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Engineering News-Record

Devoted to Civil Engineering and Contracting
McGRAW-HILL COMPANY, INC.

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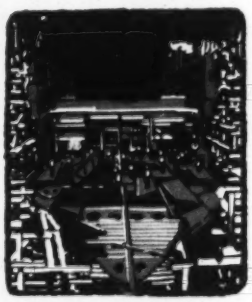
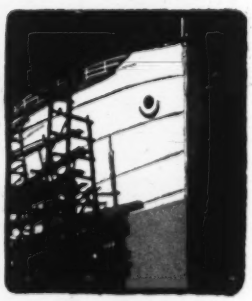


This issue is dedicated to the American shipbuilding industry, because of the contribution of civil engineers and contractors to its marvelous development and their interest in its future. Very appropriately the issue carries to the technical man a message of appreciation from Mr. Hurley and his optimistic forecast of the future.



Fabricated ship construction and the concrete ship are the leading war-born innovations in shipbuilding. What is their status? The Government has not made the answer upon which depends much of the future. For that reason facts are marshaled in this issue to give the reader a basis for independent judgment.

If the industry is to be permanent, high efficiency must be developed in the shipyard. Stimulating ideas in shipyard practice are here brought together—in the accounts of the Pacific Coast cableway rigs, the Grayhaven barge process, Great Lakes berth construction, work planning at Bristol, the ingenious yard layout at Chester and in Mr. Parry's inspirational story on the training of shipbuilders.

Are American Engineers and Contractors Wanted in France?

Results of Studies of Four Methods of Sewage Treatment
By PROF. C.-E. A. WINSLOW and DR. F. W. MOHLMAN

New Algebraic Method for Figuring Beam Deflections
By J. B. KOMMERS

Editorial Reviews of the Year's Progress

United States, Mexico, Cuba, Porto Rico, Hawaii or the Philippines, $5 per year; Canada, $7; elsewhere, $9. Single copy, 20c. Published Weekly at 10th Ave. at 36th St., New York. Entered as second-class matter April 11, 1917, at the Post Office at New York under the act of March 3, 1879.

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ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN, *Editor* — CHARLES WHITING BAKER, *Consulting Editor*

Volume 82 — NEW YORK, THURSDAY, JANUARY 2, 1919 — Number 1

"Engineering News-Record" is a consolidation of "Engineering News" and "Engineering Record."

"Engineering News" was founded in 1874 by George H. Frost, as the "Engineer and Surveyor," which title subsequently became the "Engineer, Architect and Surveyor," then "Engineering News and American Railway Journal" and, finally, "Engineering News," under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

"Engineering Record" was established in 1877 by Henry C. Meyer as the "Plumber and Sanitary Engineer. The name was subsequently changed to the "Sanitary Engineer," "Engineering and Building Record" and, finally, to "Engineering Record." During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The staff of "Engineering News-Record" is composed of

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In Honor of American Shipbuilders

IT IS an honor and a privilege to dedicate this first of the year number to the American shipbuilders, and particularly to those among them who are our own brethren—the civil engineers and contractors who threw themselves unreservedly into the work, and were no small factor in its marvelous success and development. Fittingly, the issue opens with a message to these professional brethren from Edward N. Hurley, chairman of the United States Shipping Board. With emphasis and repetition he pays tribute to what they did. What is more, he promises that the industry they helped to build under stress of war will be permanent. That his vision may not be belied, he pleads that America may become "ship-minded," that, thinking internationally, we may acquire a fostering pride that shall install shipping as a permanent American industry. If we may speak for American civil engineers and contractors in reply to Mr. Hurley, we would say that they will be no less loyal in trying to perpetuate the industry than they were in building it. The keynote for a permanent industry is efficiency, efficiency in ship building, efficiency in ship operation. Both are the work of the engineer, for ship operation involves not merely the navigation of the ship and the handling of the crew at sea but the creation and operation of terminals that will load and discharge cargo rapidly and economically. There must also be favorable external conditions—which include what Mr. Hurley terms "ship-mindedness." Here, too, the engineer and the contractor will back Mr. Hurley in his efforts to give us a permanent merchant marine.

Carrying Abroad America's Engineering Message

REALIZING the value of the international exchange of ideas on things engineering, the McGraw-Hill Company on March 1 will begin publication of a magazine dedicated to that purpose. While eventually it is expected to appear in editions in several languages, the original issue will be in Spanish, under the name, *"La Ingenieria Internacional."* It is aimed to serve Latin America and Spain. The purpose of the new magazine, which has been under consideration for some years, is to afford a medium for the presentation of those developments in American engineering which may be of value to engineers, contractors and manufacturers in other lands. At the same time, following the practice of the present McGraw-Hill publications, a far-flung editorial organization will be developed, so that there will be drawn into the paper the best of engineering practice in Latin America, Spain and other Spanish-speaking countries. Aside from this function, the new magazine will be an important developer of international good-will, and at the same time a medium by which American manufacturers engaging in export trades can carry their message to prospective buyers in foreign lands. It may be a cause of surprise that the McGraw-Hill Company, whose specialized papers circulate so widely overseas, should establish a magazine to serve the foreign field. The reason, however, is not hard to find. The present highly specialized papers appeal only to those who are situated where engineering enterprise has made such progress that there is room for the specialist and need for the last refinement in equipment and design. But everywhere, the world over, are territories newly developing, where the engineer, the contractor and the manufacturer must each turn his hand to many lines. It is to serve the general practitioner so situated that the new magazine, and its later companions in other languages, will be started.

Will Prices and Wages Drop?

ON THE theory that there will be a marked drop in prices and wages, owners are holding in abeyance their construction projects. Is their expectation correct? Prices and wages, in the last analysis, are determined by the laws of supply and demand. They were forced to high levels by the war, since the supply of materials and labor was very short and the demand very great. The volume of goods which can be consumed, in the present state of the world's warehouses, may easily exceed the war demand, but the urgency of the war demand being absent, the conclusion seems sound that price and wage levels will recede. The puzzling question is as to the extent of the recession. In all likelihood the drop will be small, for, as one shrewd observer put it, "the shelves of the world are bare." That applies as well to public works, railroad improvements and private buildings as it does to manufactured articles. Highways have been neglected, cities without number are short of housing (and therefore of water-supply, sewerage, paving, fire protection, etc.), office building space is at a premium everywhere. Price and wage levels will probably go off, but, with a still abnormal demand and a lessened man-power, not only will the pre-war levels not be reached, but the price recession within a year will not be large. Just what the recession may be no one is willing to predict. Some place 15 per cent. as a maximum, others 25 per cent. But there is quite general agreement that all of the substantial lowering will come between now and June. It would not be surprising if in some products prices would again rise after the full peace demand is felt. What is lacking in war's insistence will be made up by the optimism of a renascent world.

Are We Wanted in France and Belgium?

EVERY day the question is asked of *Engineering News-Record*, "Are American engineers and contractors wanted in France and Belgium?" This journal has been at pains to learn the answer, and the answer at the present minute is, "No." France and Belgium, so far as their agencies in this country are informed, feel confident that their own engineers and contractors can satisfactorily handle the situation. Moreover, the materials will be largely of European origin. Only for construction machinery do the Belgians and the French seem to be turning to this country. Such at least is the situation for the present. What change will be brought about when the question of credits for restoration is raised remains to be seen. If they are granted by the United States Government, there will be the usual string, for the credit will be available in this country. What seems more likely than the granting of extensive Government credits is that strong financial groups here will undertake the financing of projects abroad, and will inevitably pick out large contracting organizations to do the work. When that time comes the personnel will likely be recruited in part here and in part from our men released abroad from military service. For the present, however, we must await the decision of the French and Belgian authorities upon the method of financing the work of restoration.

Unparalleled Municipal Opportunities

NINETEEN-NINETEEN offers unparalleled opportunities to every city, town and village in the land. Hosts of soldiers, sailors and war workers will be eager for employment, contractors and supply men will be turning from military to civil contracts, engineers and other technically trained men will stand ready to plan and direct construction, all after years during which municipal improvements have been at a standstill. At such a juncture great service may be rendered, by the undertaking of extensive construction, to those who have devoted themselves to the cause of democracy at home and abroad, while at the same time industry will be stabilized, general prosperity promoted and our municipalities provided with long-delayed and much-needed improvements.

To fulfill these multiple opportunities for service requires extensive and careful planning, both physical and financial. Some cities have already done such planning, or have it well under way. Others have scarcely begun. There is no time to lose. The construction season will soon be upon us. Men needing work, and highly deserving it, will be seeking employment in ever-increasing numbers, unless every city and village does its part.

Municipal work for 1919 should be planned with a view to starting first on jobs which can be got under way early in the year, and which can be adjusted readily to the labor supply, and perhaps to the materials supply as well.

No city should look upon finding employment for the demobilized as mere stop-gap work. There will be more need than ever in this year and succeeding years to have every undertaking fit into a carefully devised municipal program. As proof of this, let any city engineer, mayor, commissioner or councilman take pencil and paper and set down needed improvements and their approximate costs. The list will soon reach such a length and total as will exceed the financial ability of the municipality for years to come. This means that work for 1919 and succeeding years must be selected with regard to its relative value and urgency.

Where city-planning commissions with vision exist, municipal programs will have been formed before this. Where they exist but lack vision, it behooves them to open their eyes and their minds and point the way. Cities without planning boards might well create them, if state legislation permits, or seek statutory authority with the opening of their legislatures, where it is now lacking. But no city or village should wait for the legislature to authorize a planning commission. Coöperation among existing officials and the mere saying the word "plan" to the city engineer may be immediately productive of results.

Where there's a will there's a way. The opportunities for municipal improvements, combined with unparalleled service, are many and great. The war has been won, but the world and this country will not have been made "safe for democracy" if suitable work at adequate pay is not provided, both now and in the future, for every soldier, sailor and toiler who helped win the war.

The world expects every American municipality to do its duty.

A Year of Apprenticeship in Shipbuilding

THERE is satisfaction of a high type in the marvelous achievement of the nation during the year—multiplying its shipbuilding power to the degree that ten times as much was constructed as in any previous year. But it is no less satisfying to find that while building we have been learning. The year has been one of apprenticeship in the shipbuilding art.

During the hard winter that ushered in the new year of 1918 a new system for producing ships was just being put to trial. The inadequacy of the old methods and equipment furnished the motive. Yet before the new fabrication system had been made a reality came a more amazing development in the sudden rise of the old shipbuilding art to a wholly new level of achievement. And it is through the power of the revivified old art, without essential aid from the fabricating yards, that the country was able to set new standards in ship construction.

Much has been said in derogation of the speed-ship work; the results have been called stagey, all prepared for. But this very point gave the clew, it soon appeared: If a good performance resulted from thorough preparation, why should not preparation precede every piece of work? The advance was made right there. Each case, "Tuckahoe" or "Crawl Keys," reinforced the preceding ones in bringing this point to the fore.

The spirit of better management was grasped quite broadly. Yard after yard, discovering that labor could be used more efficiently, and equipment more intensively, by management, set about providing for steady flow of work, preparing all tasks, guarding against mutual interference of men and of material. Yards were expanded and rebuilt, to permit of doing this. When, in the midst of this activity a shop-trained manufacturer stepped into the shipbuilding field to build patrol boats, it turned out that what he had learned in factory work and carried over into his yard was already being applied by shipbuilders.

While the old-line yards moved forward thus, it is regrettable that ship fabrication lacked time to exhibit its full power of production. It is just as regrettable that the authorities have maintained silence on what results are being achieved by this iconoclastic method. For our coming development we need to have the guiding marks set. It is gratifying, therefore, that the review which we have been able to compile of results obtained in the use of the fabrication system gives grounds for a certain amount of optimism concerning its utility.

Specialization problems lead in the shipbuilding field today. There is specialization in labor and in equipment, while there is coming yard specialization, still in its earliest stages, but clearly indicated by the yards that are planned for definite sizes of ships and the yards that are pure assembly plants, with shop processes transferred to outside enterprises as far as possible.

In the future, specialization may develop further. Mr. Hurley's strong words on the unpredictable possibilities of our renascent maritime business mean too much to pass quickly out of mind. He opens a prospect into years that may bring many new tasks. But whether the key to their solution be increased efficiency, or specialization, we are the better prepared for them by the apprenticeship of the months just past. And we are the more amply equipped by being able to center on those tasks the fresh energy of the new working forces that have been gathered into the yards.

Light Aggregate For Structural Concrete

CONCRETE is essentially an artificial stone, and it approximates to the natural material even in weight. Though largely used as a structural material in frameworks where weight is a detriment, the original nature of concrete has so thoroughly controlled its uses that little effort has been made, until the past year, to effect a desirable saving in weight with no loss in strength. In developing a light but strong aggregate, then, the concrete-ship pioneers have now opened new possibilities for structural concrete, whether or not the concrete ship is more than a war-time expedient.

The invention of a light aggregate was born of necessity. Early in their studies the engineers of the Concrete Ship Section of the Emergency Fleet Corporation found that to compete in carrying capacity, and therefore in operating cost, with the steel ship, the concrete ship could not possibly use the standard 150-lb. concrete which had come to be accepted as inevitable in structural work. Experiments were made with many substances, both artificial and natural, before approval was fixed on a burnt shale-clay resembling in appearance certain volcanic tufas of the Pacific Coast.

Full information regarding the manufacture and properties of this material will soon be made public. At present it is sufficient to say that it fully satisfies the requirements of the Concrete Ship Section, that one large ship has been built of it, and a contract has been let for 10,000 tons to a cement company which is producing the material in one of its rotary kilns. Roughly speaking, the aggregate, crushed to ¼- and ½-in. size, makes a 1:2 concrete weighing about 100 lb. per cubic foot and breaking in compression at 4000 lb. in 28 days.

Assuming that more exhaustive tests will confirm these figures, the aggregate is a most important development in concrete construction. Dead load is a serious factor in reinforced-concrete design. No small part of every concrete member goes to support the member itself, and the accumulation of these dead loads as the foundation is approached further increases the required size of every member. If this dead load can be reduced 40 or 50 per cent., not only with no loss but actually with a gain in strength, the field of concrete in structural work has been widely extended.

As in all engineering problems, this one hinges on relative cost. The probability of a wider use of a structurally effective light aggregate depends on how cheaply it can be put down at the job. On this score there are not yet sufficient data to base predictions. It can be said, however, that the basic clay from which it is made is widespread, and that the technique of production is not so complicated that it cannot readily be undertaken at any modern kiln. Already aggregates of practically identical properties have been produced in Alabama, New Jersey, Missouri and California. Assuming that production of the aggregate will be undertaken commercially, it becomes a matter of computation for each structure whether a possible increase in cost due to the

special aggregate is balanced by the saving not only in concrete and steel, due to reduced dead weight, but, in building work, in the value of the space gained by the more slender columns of the lower stories. As used in shipwork the light-aggregate concrete is rich and strong, and the aggregate itself is fine. Such concrete is, of course, expensive, but in static structures, except possibly in columns, a leaner concrete with coarser aggregates would be used.

In mass concrete, weight is often a desideratum. Specially heavy aggregates giving concrete weighing up to 190 lb. per cubic foot have been used in dams, with resulting greater efficiency against overturning or shoving action of the retained water. In articulated structures, on the contrary, strength with minimum weight is wanted. It has been the impression for years that the two properties, strength and weight, were more or less proportional in concrete, and that an aggregate which floats, as does this new burnt clay, could not possibly have a strength usable in structures. If these views are to be revised and the new aggregate has such strength as the Government studies so far show it to have, its application is readily obvious to all structural engineers. There will be placed in their hands practically a new material whose economic advantages will need consideration in all projected designs.

What War Has Done for Contracting

THE war has benefited contracting.

A year ago this statement could not have been substantiated. Even now we are too close to events to make a true estimate of their influence. Only mental myopia can, however, blind one to the main fact that the war has given contracting a spirit and a purpose not possessed a year ago. Contracting is a far more definite force in industrial affairs than it was. With the coöperation of organized engineering and organized labor, it can become the power which will recreate a new, stable, construction industry. Only the tenets of an ancient autocracy stand in the way of such coöperation. A democracy of the engineer, the contractor and the workman, dedicated to the common purpose of service to construction, is a goal which war has brought within our vision.

In canvassing the war's accomplishments for contracting, one's thought leaps first to the successful operation in war construction of the cost-plus-sliding-scale-fee contract. A work of greater creative influence has been the development among contractors of a strengthened spirit of coöperation, culminating in the organization of the Associated General Contractors of America. And still there have been other gains.

A year ago the wisdom of the new war-construction contract was being questioned. The lapse of twelve months has furnished the answer. It is this: The cost-plus-sliding-scale-fee contract has operated successfully, and should not be permitted to disappear from public-works practice. It may well be that the details of this contract can profitably be altered, but its principle of assured fair compensation should be maintained inviolate. Government officials who have directed war construction, contractors who have performed this construction, and engineers who have watched the war work are a unit in this opinion. They are supported by the record of a thousand million dollars' worth of work accomplished with remarkable speed and with astonishing harmony between engineers and contractors and workmen.

Organized contracting is, in a very definite way, the outcome of war construction. Do not misread this assertion. The elements for organization existed; war conditions merely vitalized the spirit to organize. Patriotism was one of the influences; business foresight was another; perhaps also shame at being in a position where a gratuity must be accepted instead of a right demanded. The paramount force, however, was the lesson of the power of organization which war wrote for a nation to read.

When the call came to mobilize for war construction organized labor responded, and so did an organized construction materials industry. Contractors responded, but not organized contracting. Contracting had no organization. It is true that its interests were guarded in planning the war work, but the guardians were the engineers of the Federal war-construction bureaus. It was these facts, coming home to the contractors who were called upon for war work, which crystallized the sentiment that has materialized in the Associated General Contractors of America.

Recognition of the doctrine of the partnership of labor in the construction industry is another accomplishment of war. Organized labor had a seat in the councils which determined the policies of war construction. All that followed in improved working conditions was merely an outcome of the original action. Labor has made it plain that these privileges gained will not willingly be abandoned. Nor does sound reasoning advise their abandonment. Construction, like other industries, has reached the stage in its relations with labor where the decision must be made between comradeship or battle. War construction has demonstrated that comradeship is practicable.

War, then, has educated contracting to the possibility of establishing fair-compensation contracts; to the recognition of labor's right to participate in the management of construction, and to the advantages of organization. These are great gains. Let us not overestimate them. The principle of the fair-compensation contract has not become a belief; national organization of the contracting business has barely been begun, and the right of labor to partnership in management has been recognized but not accepted. Obviously, the problems ahead are mighty ones. What of the method of their solution? War has provided the answer here, also.

Organized coöperation of engineer, contractor and workman is the primary essential. If ground gained is not to be given up, this coöperation must be immediate. What stands in the way? Distrust between engineer and contractor; intolerance by both of the claim of labor to the right of a voice in determining the conduct of work. Successful coöperation of all three, impelled by the common purpose of war service, demonstrated how superficial the reason was for distrust and intolerance. It needs only the disposition of organized engineering and organized contracting and organized labor to come together in consultation to expose the shallowness of the reason even in peace-time construction.

American Ships—A Field of Vast Technical Opportunities

A Message to the Engineers and Contractors Who Threw Themselves Unreservedly Into War Production of Ships and Now Ask As to the Future of the Shipbuilding Industry

By Edward N. Hurley
Chairman, United States Shipping Board

IN THE building and manning of our new shipyards in the past twenty months there has been a tendency to overlook the contribution of the technical man.

That contribution has been very great. Only by making generous drafts upon the accumulated technical skill of other American industries has it been possible to produce war transports and food ships in record time.

But our task of organizing and mobilizing a new shipbuilding industry in a matter of months, in the emergency of war, caused the technical factor to be lost sight of for a time. We had to achieve the superhuman. The first appeal was patriotic. Had it not been possible to stir deeply the manual workers of this country, bring them into the shipyards by tens of thousands, and stimulate them to national service, we should never have succeeded. It was necessary to create new viewpoints among craftsmen, inspire them with a willingness to learn new trades, and call upon them for unusual energy and production. Had we not begun our task at this end we should never have accomplished what was necessary under the circumstances.

Of course, neither patriotism nor human willingness could have built the ships without the quiet teamwork of the technical men.

Now that the ships are being launched and delivered and put into service, I am glad to have this opportunity of thanking the technical men, and of emphasizing what I consider to be their best achievements, and of calling upon them for even greater contributions in connection with our new merchant marine.

Contribution of the Bridge Shops

The most notable contribution has been that of the fabricated ship. It is not conceivable that we could ever have built tonnage in such record-breaking time, without fabrication. And fabrication would never have been possible without the technical skill of our bridge and skyscraper industries to draw upon. In principle, it is thoroughly simple. In practice, however, it is most complicated. For the fabricated steel ship, when she is launched and delivered, represents the assembled materials from hundreds of mills and shops. No amount of ingenuity in designing or planning would make those materials fit into their proper places without the technical skill and experience which we found in establishments hundreds of miles from tidewater. No amount of patriotism, or willingness to break riveting records, could have assembled those materials in ships had technical accuracy been lacking. But the materials have come down to the seaboard from hundreds of shops, each making parts without knowledge of other contributing organizations, or of shipbuilding, and they have fitted with a refinement which is utterly new in the shipbuilding industry.

It is high time to review our technical results, and thank the technical men for their contribution, and to point out the solid groundwork they have laid for an American merchant marine and a real shipbuilding industry.

The reviewing of technical achievements may best be left to others who have been more directly identified with those details of the work in the Emergency Fleet Corporation and the shipyards. As Chairman of the United States Shipping Board, I can express my thanks and appreciation for the results, and testify to the resourcefulness and spirit of the technical men who have faced, not merely new problems, but unprecedented difficulties, shortages and handicaps, and won out against all odds. When the history of the war is written their achievements will be found as epoch-making and as characteristically American as the achievements of our fighting forces in France.

Future of Shipbuilding

Now let us look a little into the technical future of our shipbuilding industry and our merchant marine.

Ship fabrication outside of the shipyard is unquestionably a success. Moreover, it is an American success, for no other country in the world possesses the technical resources of our bridge or skyscraper industries.

Is fabrication to be a permanent factor in our shipbuilding? Will it place us on a fair footing with other nations in cost of ship construction? Will it lead to the standardization of ships, both in hulls and equipment, and to standard practice in manning ships, and operating them, and turning them around in port?

I believe that all we have accomplished to date in this new industry points toward the fabricated standard ship. I believe that with our American facility in producing more bushels or tons or pieces per worker than any other nation, backed by the great ship-manufacturing plants which we have built for the war emergency, we shall be able to build ships as cheaply as any other nation—perhaps a little more cheaply. I believe that we shall operate ships largely with American officers and seamen, at American wages, and under American standards of living.

But we shall be able to do these things only if we apply American ingenuity and energy to the merchant marine as a whole. This is a national task. It calls for well informed public opinion and nation-wide interest in ships, first of all. Until we think of ships as we think of railroads we cannot have them—and when we think of ships in that way we can have anything.

This public opinion must be wise enough and strong enough to make all factors work together. The technical man, the ship operator, the seaman, the banker, the business man, the factory operative, the farmer, the salesman and the legislator must all work together for the common end. Ships are useless without cargo, cargo implies world trade, world trade is based upon international banking and investment, and all rest on national interest.

'I believe that within the next year we shall see this national interest develop to such a degree that the American people will never again consent to be without ocean transportation facilities.

Somebody has said that none of us owns the United States—that our country was handed over to us by our forefathers and that we simply hold it in trust to be handed over to our children. Our forefathers left us America and also an American merchant marine. We have allowed the merchant marine to fall into decadence. We owe it as a duty to posterity to reconstruct it and hand it down once more. The bare facts about our new ships are so inspiring, and our world opportunities and obligations are so great, that simply to make these facts known during the next year should be to create the necessary interest in ships.

Now, most of the technical questions as to fabrication and standardization and operation, and the future of our shipbuilding industry, seem to me to turn upon the uses to which we shall put ships when we really want them badly enough and find work for them to do.

Shipping Development to Be Our Teacher

Great economies reside in the fabricated ship. But orders for our fabricated ships have been placed by the Government for war-time bottoms. When a government needs ships by the hundred, to transport troops, munitions and food, through a great standardized service, to the war zone, that is one thing. But if the Government, following the provisions of the Shipping Board act, disposes of these ships to private operators for service in carrying cargo and passengers on many different routes, that seems to me something entirely different. One operator will require cargo carriers of moderate tonnage and speed for charters. Another will want to put ships into scheduled freight service on regular routes. Still others will plan passenger-and-cargo liners to South America or Oriental ports, and still another may wish to enter the transatlantic passenger trade with fast ships of 20,000 or 30,000 or more tons. Therefore, the kind and quantity of service determine the type of ship and the number that can be operated. That in turn determines the kind and volume of ship orders and also the extent to which fabrication and standardization can be utilized.

Was it Liebig, the chemist, who about a hundred years ago confounded the chemical experts of his day by introducing the experimental laboratory? Up to that time, they say, chemists taught entirely by theory, lecturing upon what would happen if the substance A were mixed with the substance B —but never taking the trouble of mixing them. Then Liebig came along, as I remember the story, and actually mixed A and B, and they gave reactions never prognosticated in chemical theory.

Something of the sort is likely to happen when we actually begin operating merchant ships. It is easy to see that, with ships of our own, and a revival of our world trade, we shall create new American ocean routes. With the necessary backing of branch houses and branch banks abroad, the character as well as the volume of our trade will change, both in imports and exports. This suggests not only growth of our seaports, but probably a rearrangement of traffic to seaports over our railroads and inland waterways. Quite a number of conscientious citizens—usually inspired by local pride—are already theorizing about the effect upon this or that port. Other interested citizens are theorizing about navigation laws, seamen's wages, shipboard living conditions, and like matters—and very often from the viewpoint of self-interest. But just as it would have been impossible in 1865, when the Union Army marched up Pennsylvania Ave., to foresee the railroad development of the West during the following 15 years, much less carefully to arrange it all in advance by well planned theories, so I believe we are today facing a world expansion just as difficult to foresee in detail.

One assurance may be safely given the technical men who have gone into shipbuilding and who would like to continue therein—the assurance that when the energy of America turns to world channels, as it is now doing, it will give ample scope for technical activity. The world today is 18,000,000 tons of merchant shipping short of normal needs. That is, 4,000,000 tons more have been destroyed by submarines than have been built during the war and taken over from the enemy, and 14,000,000 tons shortage exists over what would normally have been built since 1914, without war. There are good grounds for anticipating that our shipyards will be busy during the next five years building up to the world's shortage, and that for five years afterwards they will be building for the world's growth. We shall need not only ocean tonnage, but increased lake tonnage, with vessels for inland waterways, tugs and barges for harbor use, and tonnage for coastwise trade, and repair and dry-dock facilities in keeping.

Let the Nation Become Ship-Minded

Types of ships and character of shipyards and construction will depend upon the demand. Along with these factors, let the technical men remember that the merchant ship is about to undergo almost startling improvements. We have the electrically welded ship just appearing over the horizon, as well as the motor ship operated with Diesel-type engines. These two modifications in themselves should keep the technical men busy during the next decade, for they promise radically new ideas in ship operation. The motor ship, for example, will give an unheard-of range of voyages, without bunkering, increased cargo space, improvement in working conditions and morale, and probably higher wages and general emancipation for seamen.

To sum up, briefly—American shipbuilding and the American merchant marine seem to me today comparable with our automobile industry when it was in its infancy. The technical men then set out to meet a known demand for road transportation with several distinct types of propulsion, such as the gasoline and the steam engine and the electric motor. The demand for vehicles far outran all anticipations. It determined the type of car, led the technical men into unforeseen fields of development, and, by modifying our whole national scheme of living, created an industry which has never since shown any signs of lagging. I believe that in shipbuilding and the merchant marine we are entering one more great field of unconditioned possibility.

Let us all work now to the end that this nation may become ship-minded, and the future will be ample enough for everybody.

Berth Construction and Side-Launching Practice in Great Lakes Shipyards

Berth Structure Simple—Timber and Concrete Foundations for Support of Ships—Concrete Launching-Way Stringers at One Yard—Keel-Blocks and Cradles Variously Arranged—Trip Shores To Release Ships

HIGH-PRESSURE shipbuilding in the yards of the Great Lakes has emphasized the simplicity and cheapness of berth construction and the saving of time secured by side launching. Ships can be laid down almost anywhere along a dock front, with little preparation of the berth. No submerged ways or other underwater work are required. The ways can be cleared and a new keel laid in much less than an hour. Building the ship on an even keel eliminates extra labor and delay in lining up the parts of the hull. Much ingenuity has been applied to the details of the method. It appears in modifications of timber berth foundations, the use of concrete substructures, quick-release keel-blocks of different forms, and variations in launching-way and cradle arrangements. The extensive enlargement of old yards and construction of new ones during the past two years because of the urgent demand for maximum ship output has created special opportunities for applying new ideas.

FIG. 1. LITTLE PREPARATION OF GROUND NEEDED FOR LAYING DOWN A SHIP IN A SIDE-LAUNCHING YARD

In a review of Great Lakes shipyard practice in *Engineering News-Record* of Nov. 28 and Dec. 5, 1918, pp. 978 and 1037, the various yards are listed and their main operating characteristics summarized. It may be referred to in connection with the present article.

Timber Berth Construction—Berths on firm fill require but little preparation of the ground for laying down a ship, as the view (Fig. 1) in the newest yard of the Lakes, the McDougall-Duluth Co. yard at Duluth, Minn., indicates. The keel-blocks are set on stringers founded on piles, as the soil is backfilled behind the timber dock front, but for emergency use this preparation could be dispensed with. In general, the company's timber berth construction is like that shown in Fig. 6 for its concrete berths, with timbers in place of the concrete caps. It is a longitudinal system.

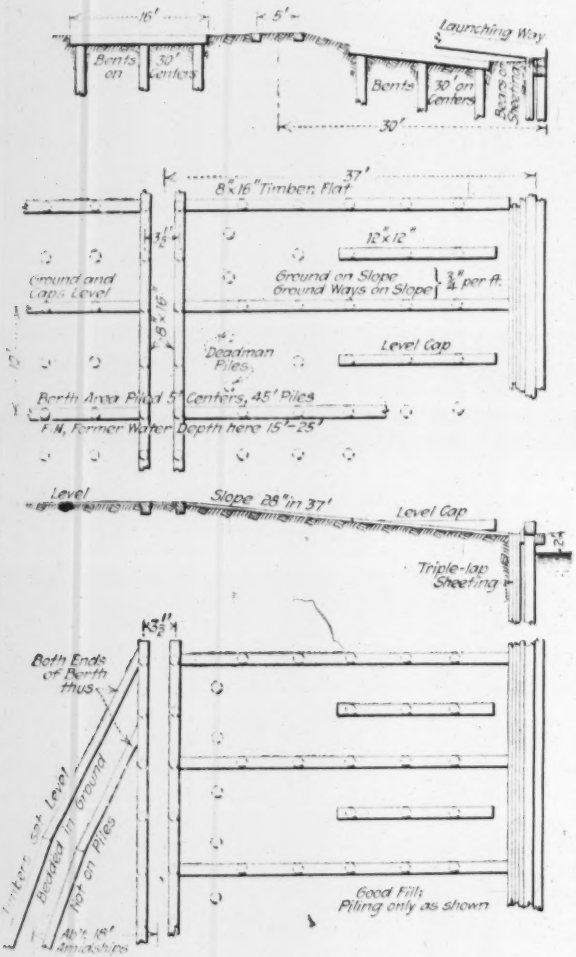
Several new berths of the Manitowoc Shipbuilding Co. at Manitowoc, Wis., are of the very simple type sketched in Fig. 2. A keel-block foundation consisting of two longitudinal stringers supported on piles runs down the center of the berth, and pile bents at right angles to the dock line give support for cribs or ways. The bents on the water side are set on a slope somewhat less than the launching slope of 1½ in. per foot, while those on the land side are level. The berth as a whole is not piled.

Somewhat more extensive foundation work, providing supports at 5-ft. intervals, was used in the four old berths, and was adopted again in building the new berths 5-9 of the American Shipbuilding Co.'s yard at Wyandotte, Mich., sketched in Fig. 3. Piles were driven 5 ft. on centers all over the berths; there was 20 ft. of water on the site of berths 7-9 only a year ago. The main bents are 10 ft. apart, and those on the water side have only half the launching slope, to give more room under the ship at the keel-block foundation level. Intermediate between the sloping caps are shorter level caps.

Stringer construction of a special kind is used on the land side of berth 10, the last one built at Wyandotte; its arrangement is sketched in Fig. 4. The water side of the berth is identical with that just described, except for the omission of intermediate piling, because of older and firmer fill. In the land half the ground is so firm that the stringers were laid without pile foundation. Direct bearing on the stringers of all main supports of the ship during construction is to be furnished by the arc-shaped pair of stringers. For supporting the launching ways, which carry load only an hour or two, blocking direct on the ground appears to be satisfactory.

McDougall and Toledo Have Concrete Berths—By substituting reinforced-concrete caps for timbers in some of the berths, the McDougall-Duluth Co. has produced a simple form of permanent foundation. It follows the stringer system on both land and water sides. Fig. 6 shows the layout and main dimensions. These concrete berths are the ones intended to be continued in service after the emergency shipbuilding is over.

More elaborate concrete berths are used by the Toledo Shipbuilding Co., Toledo, Ohio. They were built ten years ago, but are still practically in new condition, in spite of constant service. They consist of a complete gridiron of way bents and stringers or struts, arranged around a backbone formed by a heavy longitudinal girder under the keel-blocks. The water-side work is sloped to the inclination of the launching ways, and permanent 6 x 18-in. oak ways are bolted to the concrete caps of the transverse bents from this side. On the land side the concrete structure is level;



FIGS. 2 TO 4. VARIOUS FORMS OF TIMBER BERTH CONSTRUCTION USED IN GREAT LAKES YARDS

Fig. 2—Timber berth construction at Manitowoc. Fig. 3—Piled substructure of berths 7, 8 and 9, Wyandotte Yard. Fig. 4—Combined transverse and stringer type used at berth 10 at Wyandotte

hinged launching-way sections here can be raised up to the way slope. After a launch, they are dropped down to give free working room for setting keel-blocks and laying a new keel. Later they are taken out, at leisure, to leave the berth space clear, being easily replaced when preparations for the next launching are to be made.

Protection covers are provided for the fixed way timbers (on the water side), but they are rarely used. Lugs for launching-trip supports are formed in all the transverse concrete caps, so that the trip shores used in releasing a ship at the time of launch can be set anywhere.

Firm support is afforded by the concrete structure for the outboard rail of the gantry cranes with which the Toledo berths are equipped. This rail can be removed or replaced in a few minutes' time, and by reason of the firm foundation no time is lost in lining it up.

Wedge Keel-Blocks Save Time in Launching—While building, the ship is supported by keel-blocks (Fig. 1)

FIG. 5. TOLEDO YARD HAS FIXED LAUNCHING WAYS ON CONCRETE BERTH FOUNDATION

and props or shores just as in end-launching practice, except that it is level in both directions. Safety cribs are built up near the bilges as the ship grows, to give it stability independent of the shores. In the Cleveland yard of the American Shipbuilding Co. cribs are used on the water side only—three cribs, each 4 or 5 ft. square. Most other yards place cribs on both sides, and use eight to twelve in all.

As all the fixed supports must be taken out for launching, and their load transferred to the sliding blocks or cradles resting on the ways, special devices for releasing their load are used in many yards. The shores carry each only a small amount of load, and they are therefore easily knocked out after the ship has been wedged up on the cradles. The keel-blocks, however, which carry most of the load, are so held between foundation and ship that they cannot be knocked out. At Cleveland the top block, on which the flat keel rests, is a piece of 12 x 12 about 18 in. long, and in order to take the load off the keel-block at launching time this upper block is split out by steel wedges. For 30 keel-blocks the operation of splitting out—working at two simultaneously, so that there are 15 operations—takes the better part of an hour and keeps a large crew busy. Quick-release wedges have, therefore, been devised in several forms and are widely used.

Wedge blocks of the type shown by Fig. 10 are used in many of the yards either on the end blocks only or on all the keel-blocks. At Cleveland they are used only on the four end keel-blocks at stem and stern and (after the link is unbolted) they are knocked

cut with a ram after the other blocks under the ship have been cut out—this being the final step in transferring the ship's weight to the cradles and putting strain on the trip-shore ropes so that the ship will start when the ropes are cut. The McDougall-Duluth yard uses these wedges on all keel-blocks, and so saves the work and delay of splitting out blocks; it also uses them on the safety cribs, as sketched in Fig. 11.

An ingenious double-wedge block, the Thompson keel-block, has been adopted at Manitowoc. This was originated by one of the company's carpenters and patented by him. It provides not only for quick release, but also for easy adjustment to proper height at the time of laying the keel, or later in replacing a keel-block after it is taken out for riveting the keel directly above. As sketched in Fig. 12, it consists of a bottom wedge whose upper sloping face is roof-shaped with longitudinal ridge, and two upper blocks bearing on the side slopes of the roof surface. The upper blocks are bolted together, but for releasing, after the bolts are taken out, they can be knocked away easily. When in place and bolted up they may

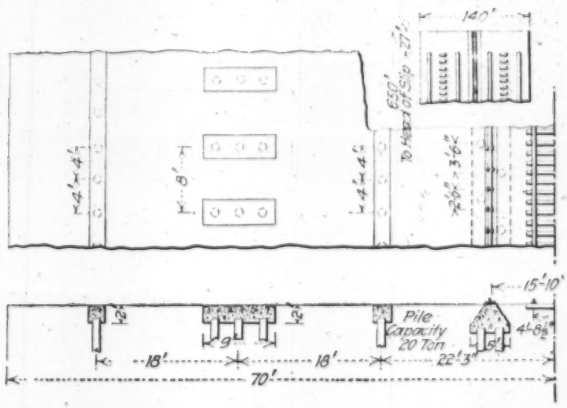
FIG. 8. TEMPORARY SILL LAID ON SAFETY CRIBS TO CARRY BOTTOM SHELL

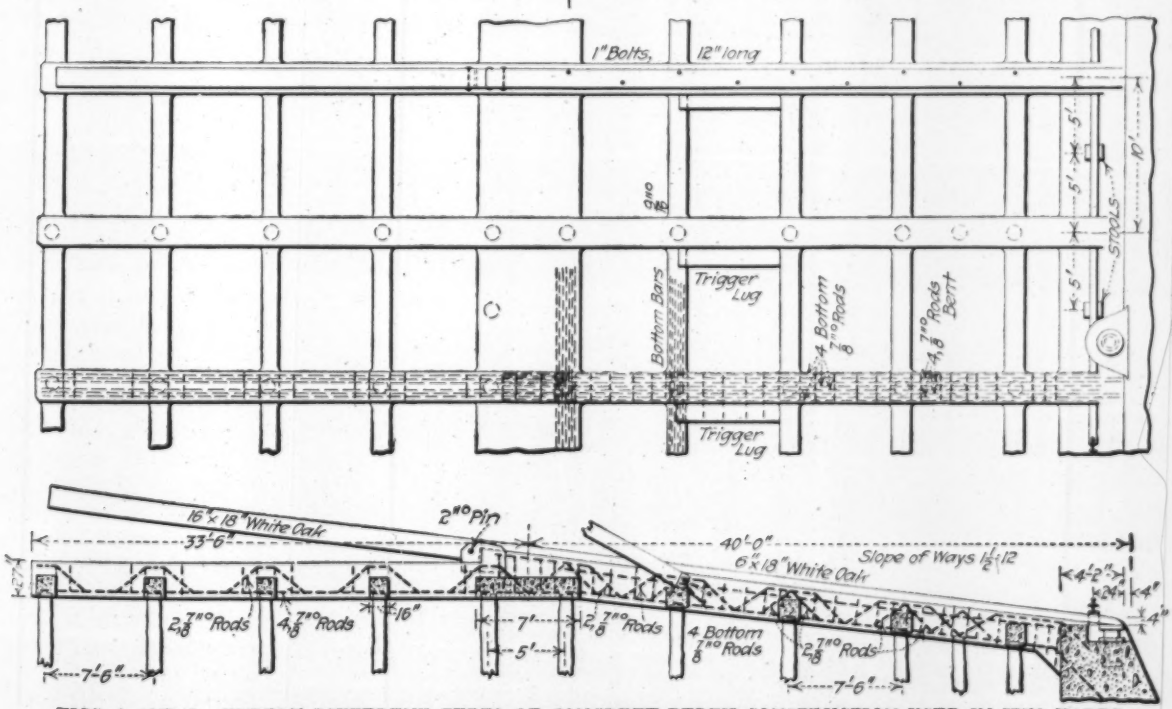
be shifted lengthwise on the lower wedge for height adjustment. An important saving in launching time has been realized through the use of this block, as explained farther on.

Simple wedge blocks are used at the South Chicago yard of the Chicago Shipbuilding Co., as may be seen in Fig. 15. They are sketched in Fig. 13.

Toledo also uses blocks wedged on both sides, as can be seen also in the view, Fig. 5.

Launching Ways and Cradles—Twice as steep a launching slope is used in side launching as in end launching—1¼ to 1½ in. per foot, as compared with ⅝ in. to ¾ in. The ship must acquire a considerable velocity to make its drop at the end of the ways properly, in view of the retardation produced by the ship's outer bilge entering the water just before the final drop (Fig. 16). Fig. 9 shows the general declivity of the launching ways as set for a 600-ft. ore steamer at Ecorse. A nearer view of the way surface as pre-





FIGS. 6 AND 7. WIDELY DIFFERENT TYPES OF CONCRETE BERTH CONSTRUCTION USED IN TWO YARDS

Fig. 6—McDougall-Duluth concrete berth foundation. Fig. 7—Concrete foundations for blocking and ways as built at Toledo

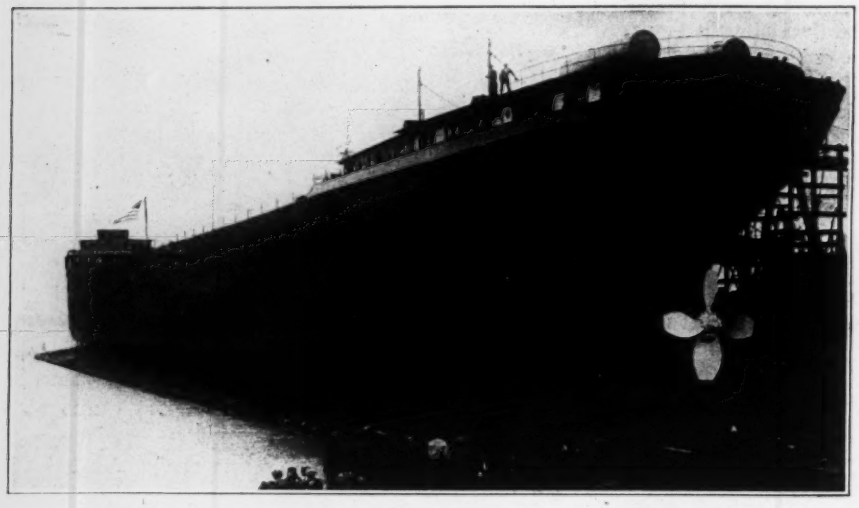
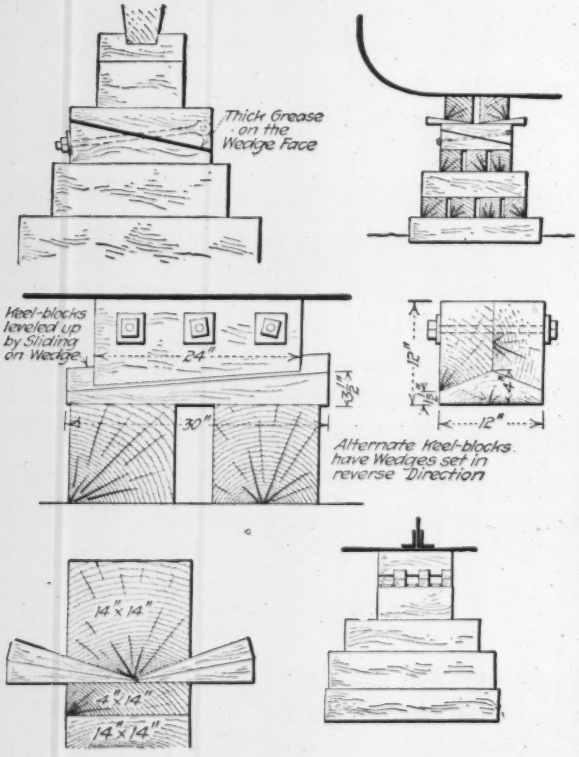


FIG. 9. TEN TRIP SHORES USED FOR 600-FOOT LAKE STEAMERS; EMERGENCY FLEET VESSELS REQUIRE ONLY FOUR

pared for one of the short Emergency Fleet ships appears in Fig. 17.

Timbers 18 x 24 to 20 x 20 or 24 x 24 are used for launching ways (Fig. 18). They are spaced 10 to 12 ft. apart (for example, 12 ft. at Cleveland, 10 ft. at Toledo and Wyandotte), in uniformly spaced arrangement, except at Duluth, where the interesting twin-way arrangement shown by Fig. 19 is used.



FIGS. 10 TO 13. WEDGE KEEL BLOCKS USED AT CLEVELAND, MANITOWOC, SOUTH CHICAGO AND TOLEDO

Fig. 10—Wedge block with locking link used on end keel-blocks (Cleveland). Fig. 11—Safety crib with quick-release wedge block (McDougall-Duluth). Fig. 12—Manitowoc duplex wedge keel-block. Fig. 13—Arrangement of wedges in keel-blocks at South Chicago.

Blocking under the way timbers, directly on the ground, forms their foundation. The forward end of the ways is usually supported on the bulkhead wall of the dock. The regular practice is to let the forward end of the timber bear on the main 12 x 12 pile cap of the dock front. At Manitowoc the timber is made to bear on the sheetpiling of the bulkhead and is kept clear of the pile caps (Fig. 2), as the former is considered better able to take the extra load as the ship passes over. At Ecorse, however, the ways are not allowed to bear on any part of the bulkhead, but are placed to clear the cap timber by about 3 in. (Fig. 20), the support being given wholly by blocking on the ground. Relatively light bearing pressures are developed between the sliding cradles and the ways. With the Emergency Fleet ships, weighing not over 1200 tons at launching, the total area of sliding surface is 250 to 400 square feet, giving three to four tons pressure on the sliding surface. With long Lake ships the pressure may be 9 to 10 tons per square foot. The American Shipbuilding Co.'s standard arrangement of ways and cradles, used with minor modifications at each of the company's six yards and representing fairly closely the general Lakes practice, is shown in Fig. 18, which exhibits the relation of ways and cradles to the ship and the edge of the dock. The ways do not extend down into the water so as to give support to the ship until it is floated off the cradle (as in end launching), but stop short at the edge of the dock. Launching involves a tipping of the ship just before the vessel finally leaves the ways, as the view Fig. 16 clearly portrays. The action is as sketched in Fig. 21, representing a

FIG. 15. WEDGE BLOCKS AT CHICAGO USED AT EVERY KEEL SUPPORT

FIG. 14. TRIP SHORE THRUST TRANSFERRED FROM LAUNCHING WAY TO ANCHOR RODS AT WYANDOTTE

FIG. 16. LAUNCHING WITH LOW DROP AT LORAIN; THE "LAKE DEVAL" WAS BUILT IN 24 WORKING DAYS

diagrammatic transverse section through the ship at the time of launch. Supported on its five lines of cradles, the ship when released moves down the ways from position A to positions B and C. By the time position C is reached the two lines of cradle

FIG. 17. SHIP TRANSFERRED TO CRADLES READY FOR LAUNCH (CLEVELAND)

on the water side, 1 and 2, have already passed over the ends of the ways and dropped out. At position C, the center line cradle K also drops out; the vessel then is unbalanced and pivots on cradle 3. While tipping to position D and beyond, it continues to move forward and strikes the water in position E. Forward movement continues, and the resistance of the water applied at the bilge increases the tipping moment and tends to relieve the load on the rear cradles. When cradle 4 drops out, the vessel soon settles to an even keel.

Ordinarily, the end of the ways is only a foot or two above the water surface, so that conditions are fairly represented by the sketch, Fig. 21. Much higher drops, however, occur at South Chicago (4 to 5 ft.) and at Buffalo. A new berth at Buffalo has a dock front about 7 ft. high, so that the keel of the ship is 10 to 12 ft. above water at the moment when the drop begins. At low water in the extreme case the drop is about 12½ ft., and this was the condition at the time the "Lake Delancey" was launched, on July 4. Fig. 23 shows how the ship took the water.

The cradles on which the ship moves down the ways are relatively simple arrangements of blocking in the flat-bottomed ship now being built. A row of center-line cradles the full length of the ship and two shorter rows of cradles on either side of the center line constitute the common arrangement. Six cradles are used at Duluth (Fig. 19). Wedges in the upper tiers of each cradle (see cross-section in Fig. 18) are the means for lifting the ship to transfer the weight from the shores and keel-blocks to the cradles. At Cleveland the cradle on the land side, which comes just inboard of the turn of the bilge, is blocked solid from way-timber to ship, and the wedges are set under the way-timber.

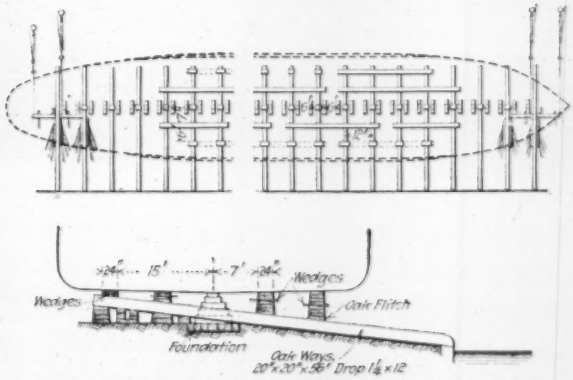


FIG. 18. TYPICAL ARRANGEMENT OF KEEL-BLOCKS AND CRADLES, AMERICAN SHIPBUILDING COMPANY

This is done partly because when put under the way, the wedges tend to lift its upper end.

More common practice has all the wedges above the ways, (sketched in Fig. 24) as at the Wyandotte yard. Single wedges are used in the cradles, except in the center-line cradle. The two cradles on the water side are tied together transversely by tie planks about mid-height, for greater stability.

Oak or maple sliding blocks are used on the ways, of a length not greatly exceeding the width of the ways

(usually 24 in.). In the twin-way arrangement used at Duluth, the sliding blocks or "butter boards" extend across the two ways of the twin pair. Their length of 8 ft. gives 6 in. of projection over the sides of the ways. Using the long butter boards and having two ways in a pair is believed to offer greater security

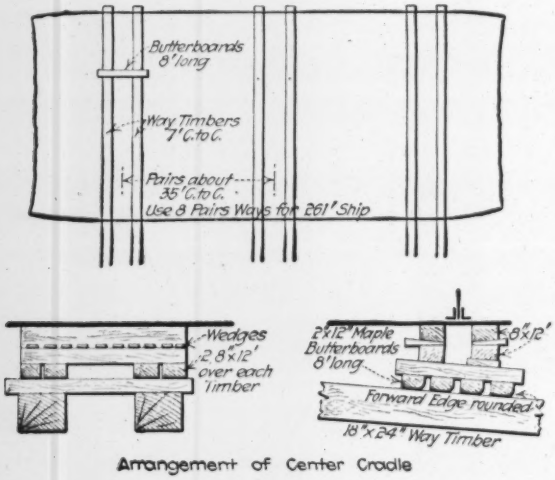

Butterboards 8' long
Way Timbers 7' C. to C.
Pairs about 35' C. to C.
Use 8 Pairs Ways for 261' Ship
Wedges 2 8"x12" over each Timber
2"x12" Maple Butterboards 8' long
8"x12"
Forward Edge rounded
18"x24" Way Timber
Arrangement of Center Cradle
Distribution of Cradle Butterboards

FIG. 19. TWIN WAYS AT DULUTH

against the cradles leaving the ways in case one end of the ship is released before the other and the ship skews during the launch.

Releasing the ship is accomplished by cutting the ropes holding trip shores constructed according to the drawing, Fig. 25. Each trigger consists of a lever parallel to the center line of the ship, one end resting against an abutment arranged on the side of a way timber and the other held by a bight of 1½-in. rope securely anchored inshore. This lever is about 10 ft. long. About a foot from its abutment or fulcrum end

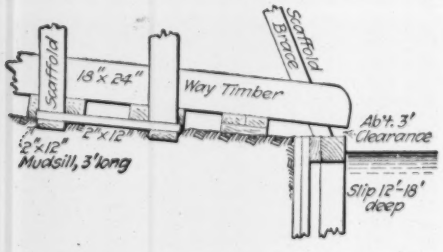


FIG. 20. ECORSE WAYS ARE KEPT CLEAR OF BULKHEAD

a short post footing against the lever bears against the keel of the ship or a ledger-block fastened to the side of the ship. In launching the 600-ft. ore steamers which constitute the main carriers of the Great Lakes, often four trip shores were placed at each end of the vessel and two near the center, making a total of 10 that had to be released simultaneously. The short 261-ft. vessels being built for the Emergency Fleet Corporation are launched with two trip shores at each end, four in all, arranged as sketched. The vessel shown in Fig. 9 is held by ten ropes, the four stern trip

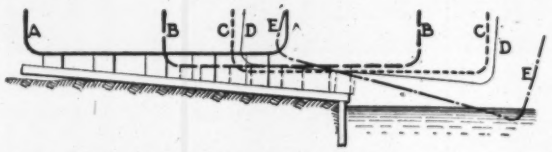
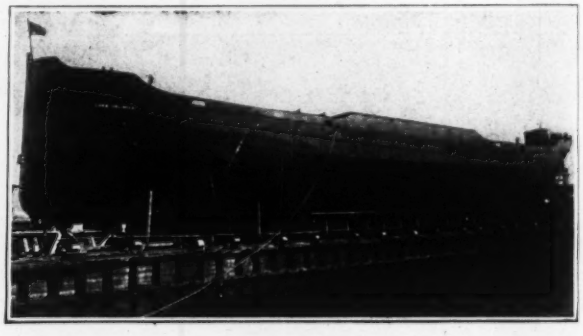


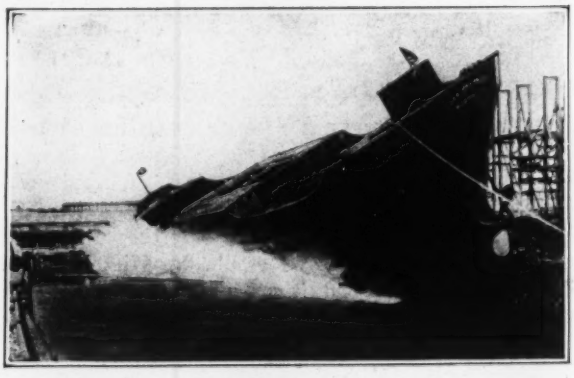
FIG. 21. SIDE-LAUNCHED SHIP TIPS AS THE CENTER-LINE CRADLES GO OFF WAYS

shores being visible in the picture. The two trip shores used for the Emergency Fleet vessels show clearly in Fig. 17, a view of the "Lake Alvada," launched Aug. 18 at the Cleveland yard.

As shown in Fig. 25 (see also Fig. 18), the thrust of the trip shores against the launching ways is absorbed by raking struts bracing the way timber which serves as abutment. An anchorage arrangement used at Wyandotte, shown in Fig. 14, transfers this thrust from the insecure ground at the berth to secure anchorage timbers some distance back. The same timbers serve for holding the ropes by which the long end of the trigger lever is held.

Hydraulic or screw jacks are placed against the side of the ship, one near each end, to start the ship from its static conditions before the ropes are cut. Most yards pump up these jacks in every case, to make sure





FIGS. 22 AND 23. LAUNCHING FROM HIGH DOCK—BUFFALO YARD CONDITIONS INVOLVE DROP OF 10 TO 12 FEET

that no obstruction is present and that the ship will start promptly.

Typical Launching Procedure—Transferring a ship from its fixed blocking to the cradles and launching it is an operation of an hour or an hour and a half. The following description of the procedure is from notes taken during a launching at the Cleveland yard, but the steps are substantially the same in all the

Lakes yards. At the start of the work described, the vessel rests on its keel-blocks, on one or two rows of posts or shores near each bilge, and on three to twelve safety cribs, also located near the bilges. The launching ways are in place, all the cradles are on the ways, with launching tallow between the contact surfaces, and are lightly wedged up against the ship.

Putting the entire launching gang on the water side of the berths, the launching boss clears this side of its fixed supports, as the first step. The men working in pairs, drive in the wedges of both lines of cradles on the water side of the ship; after a first "rally" of two or three minutes, followed by a breathing spell of the same length, a second rally transfers enough load to allow the shores to be knocked out. Simultaneously with removal of the shores, the cribs on this side of the ship are taken out by knocking out the wedges in the blocking. The water side of the ship is then free and on its cradles. Repeating these operations on the

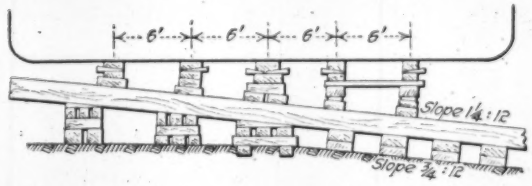


FIG. 24. CRADLE ARRANGEMENT AT WYANDOTTE

land side clears the ship of all fixed supports except the keel-blocks.

Trip shores and releasing ropes were placed on the previous day, and the ropes drawn up by tackle to a good strain. Everything is therefore ready for the removal of the keel-blocks. Beginning at the center, the blocks are split out, in pairs, first the two blocks amidships, then the one forward and the one aft of these, working on successively to the ends of the ships. When all are split out, the four end keel-blocks supported on wedge blocks tied by linke (Fig. 10) still hold the ship. The links are taken out and eight squads of men with heavy planks as battering rams get in position to knock out the eight sets of wedge blocks.

For even launching, the four ropes holding the ship must be cut simultaneously, and the ship must be ready to move. The latter requirement is assured by giving the ship a slight shift by means of the jacks before cutting the ropes. To make sure that the cutting goes on as a single blow, four axemen, one at each rope where the rope passes over a chopping block, work in conjunction with the launching boss and his two assistants in such a way that one signal is carried to all four. Close to each end of the ship is stationed one of the assistants, where he is in plain view of the two axemen at that end. Halfway between them, and in a little, back from the ship, the superintendent stands on a platform or box, in clear view of the assistants. Each of the latter has tacked to a rail in front of him and facing the boss four sticks or semaphore markers.

At a signal, the first ram gang at each end knocks out the wedge keel-block farthest from the end of the ship; the moment it is clear the assistant in charge turns down the first of his four markers. The other wedge blocks are then knocked out in order. As the last supports go out, the cutting ropes should show the strain of the ship's pull, and the last of the four markers is not turned down until the assistant in charge has made sure that this is so—in other words, that the ship is "alive"—otherwise, the jacks are applied to start the ship.

When the turning down of the last marker informs the superintendent that both ends are clear and alive, he slowly raises his outstretched arms, a signal to the axemen to raise their axes. The assistants at the ends follow him in this movement, and the axemen in their turn. After a moment's pause, the launching boss brings down his arms, and the signal goes through the chain to the axemen and results in a simultaneous cut on all the ropes.

Preparation for the launch may be started as soon as the ship's bottom is riveted; after this time there is no more occasion for working under the ship, so that ways and cradles do not interfere with anything. Ordinarily, however, no ways are set until about two weeks before the intended launching date, and if further delay is desirable the work may be started as late as a week before launching.

Launch Ship in Ten Minutes by Help of Wedge Keel-Blocks—Remarkably fast work in launching is accomplished at Manitowoc by a change in procedure which was developed after the adoption of wedge keel-blocks of the type described. The last half dozen launchings

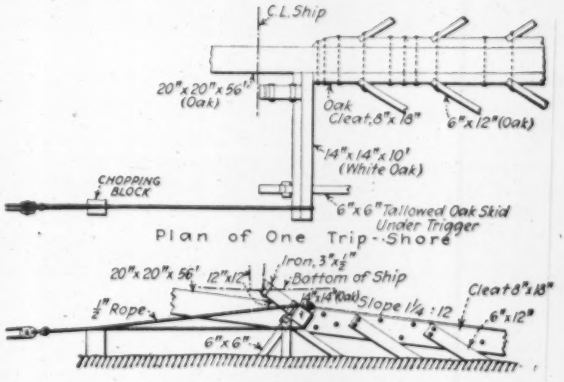


FIG. 25. TWO TRIP SHORES AT EACH END RELEASE THE SHIP; FOUR ROPES CUT SIMULTANEOUSLY ON SIGNAL

at this yard were made in about 10 min. each, from starting time to the moment the ship struck the water. A description of the method is contained in the following memorandum of Elias Gunnell, president of the Manitowoc Shipbuilding Company.

"The launching gang hardens up the upper side of the vessel and removes all shores and cribs on that side, in advance, so that on launching day all that is necessary is to harden up the lower side and remove the lower or river-side cribs and shores. There is no attempt to raise the vessel off the keel-blocks. After taking out the bolts a wedge is driven between the two pieces of the upper block, and the block comes free. Our last six launchings averaged just 10 min. from starting time to water. This time could be cut, but counting on the regular run of launching gangs that we use in these days, bolters and helpers, it is good time."

What the Year Has Taught About the Concrete Ship

Much Learned Regarding Design and Construction—Future Depends on Ability To Build in Cost Competition with Steel—Structurally, Ship Is Success

(Editorial Review)

WHEN the United States entered the war the concrete ship was unknown in this country. When the armistice was signed the Government itself had over a hundred ships and barges under contract, one American vessel had finished a 12,000-mile voyage ending at New York, and millions of dollars had been put into yards where vessels from 7500-ton oceangoing tankers down to 500-ton canal barges were being built. This new industry was developed practically in its entirety by engineers and contractors who had before no experience in ship design or construction. Whatever future it may have will undoubtedly remain in the hands of the concrete constructor who brought to the problem native ability and experience in the general art of concrete construction. Now that the war is over and the immediate critical need which developed the concrete-ship idea has passed, many are asking what has been learned in the past year and what are the chances for the concrete ship as a permanent competitor of the vessel of wood or steel. Even now it is too soon to do more than review certain obvious conditions and developments and to set down briefly some of the things that have been learned.

The history of the concrete ship has been told in these pages during the past year. It suffices now to repeat that the development was, early in the war, taken over by the Concrete Ship Section of the Emergency Fleet Corporation, and that the Shipping Board soon refused to allow any ships to be built for private account. In consequence, though hundreds of engineers interested themselves in the study of the problem, the only ships contracted for were those built under the auspices of the Fleet Corporation, except some small power boats and lighters for the War Department, towboats for the Railroad Administration and the Navy, and a few barges for private owners. The Concrete Ship Section conducted many studies in design and construction and, though handicapped by what at best may be termed a lack of sympathy in some quarters in the Fleet Corporation, is, together with its associated contractors, entitled to the major part of the credit for what has been done.

Design Based on Theory, Not Rules

Many pages might be written on the design of the concrete ship. In fact, many pages have been written recently. They all reduce to the fact that the usual ship-design methods have been used to determine bending moments, although strain studies now under way on actual ships may modify these methods in the future. The difficulty in design comes in proportioning members to meet the assumed moments according to theory rather than according to standardized rules based on past practice and performance, as has been the practice with steel ships. Distribution of shear in the shell has been particularly bothersome, and has been met in some cases by assuming larger unit stresses than have been common, though apparently justified by incomplete tests, and in some ships not yet beyond the design stage by radical rearrangement of the frame so that the shell takes no shear.

Construction Problems Many

Ship lines in the early ships, particularly in the "Faith," were very crude. The opposite extreme was reached in the first Government ship, the "Atlantus" launched last month at Brunswick, Ga., which takes on the appearance of a yacht and which, due to the very extreme fairing, was difficult to build. Between the two extremes lie the latest Government ships which have sufficient curving of the lines to present a good appearance, but which are not particularly complicated in form.

It is in construction of the concrete ship that most has been learned. It can be definitely said, for instance, that the claim of the violent advocates of a year ago, that no skilled workmen would be required on a concrete ship and therefore it could readily be built anywhere with little difficulty, is not true. No one who has gone through the first few months of building one of the large concrete ships will deny that the work requires the highest type of skill, and that even the training gained on reinforced-concrete buildings is inadequate—because, primarily, of the greater accuracy required in placing the steel and forms and of the greater congestion of the steel in the forms. A concrete ship does not require as many kinds of skilled labor as does the steel ship, but the labor that it does require must be of the highest type.

Placing Steel Difficult and Expensive

Difficulties which arose in the construction were mainly those connected with the placing of the steel in the narrow, congested forms. Contrary to many expectations, the construction and erection of the forms themselves have not proved overly difficult. It was, of course, a problem different from that met in building construction in that the whole form structure, inside and out, had to be erected complete before any concrete pouring started. In addition, all of the forms so erected had to be arranged in such manner as to allow free access inside the boat during the pouring, and a ready method of stripping, so as not only not to injure the concrete itself, but to preserve the forms for subsequent use. This has been met quite successfully and, so far as shown by figures given out, quite economically.

Placing the steel has been the critical element in the construction of both barges and ships. Bending itself has been very difficult. The curves are complicated and diverse, so that templets have to be changed frequently. Much of the steel is large in diameter. In none of the boats so far built has the cost of this work been reduced to what it may be ultimately. Placing the curved steel has still further complications, not only on account of the difficulty of fitting it to the curves in the forms, but

also because of the accuracy in its spacing which is required. Undoubtedly, with practice, the bending and placing of steel will be made cheaper. Indeed, it must be made so if the cost of the ships is to be brought down to a competitive basis.

Mechanical Hammering an Innovation

The element of mixing and placing the concrete has not given the trouble that was possibly anticipated. In fact, it has been shown that getting the concrete to the forms themselves is a minor detail, and no great elaboration of plant is required to insure it. The narrowness and the general congestion of the formwork make it difficult to place the concrete in the forms, so that delivery to a nearby point from which shoveling to the forms may be done requires only a moderate speed and quantity of concrete.

The placing of the concrete, however, could hardly be done at all successfully without the use of the air or electric hammer, which has been introduced by the Concrete Ship Section in the making of all of the Government ships. As stated above, all the forms in the ship must be up before the concreting starts. This leaves many bends and turns inside the forms around which the concrete must be led. The ideal consistency attempted by Mr. Edison in his concrete-house project of a decade ago is what the concrete shipbuilder would like. Lacking this so far impossible mixture, the hammer is the next best thing. Several of these hammers battering the inside forms during the pouring of the concrete permit the use of considerably drier mixture than used to be employed in thin, heavily reinforced wall work, and performs almost incredible feats in leading the concrete into the corners of the forms.

Behavior Tested in But One Ship

So far as performance of the concrete ship is concerned, our whole dependence is on the freighter "Faith," which was dry-docked in New York in November after a voyage down the Pacific to South America, up to New Orleans, thence to Havana, and up to New York. Barring the rather serious cracks in the deck where a winch was seated in a place not intended for it, the ship, to all outward appearances, is intact. All rumors to the contrary notwithstanding, her hull is free from anything but minor hair cracks, and the outside surface, which has been subjected to sea-water action for nine months, is in as smooth and unpitted a condition as any concrete in the dry air of the interior of a building.

The "Faith" is as "ugly as original sin." Her structural design, according to those who have investigated it, is susceptible of considerable improvement. She is heavy and therefore undoubtedly uneconomical, but she is an oceangoing concrete vessel which has successfully passed a long sea test.

What is the future of the concrete ship? It is still too early to draw definite conclusions, but the experience of the year seems clearly to indicate that structurally the problem is solved; improvements are bound to come, but the fears of a year ago as to difficulties in erection and dangers in service need not deter progress. The future today is bound up in costs. Competition with steel ships rests on cost per ton of freight carried, which is tied up to original cost plus carrying capacity per ton displacement. The concrete ship will have to be built sufficiently cheaper than the steel ship to counterbalance the extra cost of the dead weight, which is still higher than for the steel ship, despite the advantages of the new light aggregate.

This light aggregate, an artificially burnt clay developed by the Concrete Ship Section, gives promise of being a most important step forward in concrete-ship work. Weighing less than water, it produces in a 1:2 mixture a concrete having a weight of 100 lb. or slightly more, and a strength at 28 days of 4000 lb. By its use it is possible to produce a concrete ship with a carrying capacity to dead-weight ratio only slightly below that of the steel ship—so close, in fact, as to bring the two types in competition.

So far figures for the oceangoing ships have not been produced showing the closeness of this competition, but in towboats they have been made. Barges of identical dimensions, for instance—one of steel carrying 600 tons and one of 150-lb. concrete carrying 500 tons—have operating profits practically equal, using actual contract costs and identical freight charges. A barge built with the 100-lb. concrete would naturally show greater profit.

The costs of the seagoing ships have been confused by a number of things. The "Faith" is a private venture for which costs are not available. The first Government ship, the "Atlantus" will prove to be inordinately expensive. Until official explanations are given out, exact causes cannot be stated, but it seems evident that the slow construction and high cost were due to a combination of inexperience in concrete design and construction, a lack of proper plant equipment due to the fact that only one ship was to be built in the yard, a possibly praiseworthy experimentation with methods and devices, and—so many reports go—shiftless labor.

It is unfortunate that this first Government ship should have taken so long to build and have been so expensive, because it will undoubtedly be used as an argument against future development. Meanwhile, the other Government yards have been built at large expense for eight ships apiece. The big ships being turned out from these yards apparently are being built cheaply enough to permit them to compete fairly with steel vessels, *if the proper proportion of plant charge is assessed against each.* The responsibility for giving out full and authentic cost data on the concrete ship rests squarely on the Emergency Fleet Corporation. Only by knowing these figures can shipowners or prospective builders form their judgment of the practicability of this new kind of vessel.

Concrete shipbuilders are learning their trade in the hardest of schools. They cannot produce as efficiently or as cheaply now as they will after their first few units are turned out. It is going to take the backing of the Government or of courageous spirits such as those who financed the "Faith" to continue the big concrete ship as a commercial proposition, but the future is bright for any such venture. For the small barge, car-float or lighter, on the other hand, the field seems more immediately open. A number of contractors have learned to build such boats, and their experience should be worth much in reducing costs to a competitive basis.

Fabricated-Ship Construction in One Year's Experience

New System Now Thoroughly Tested by Large-Scale Working Has Proved Adaptable And Free from Inherent Difficulties or Elements of Excess Cost

(Editorial Review)

SINCE the "fabricated-ship" enterprise was launched by the Emergency Fleet Corporation as a war-time experiment, 15 months ago, actual hull construction has been in progress for a full year. The system has undergone a thorough, practical trial during this time. Its feasibility has been shown by the launching of a large number of fabricated ships, and the completion and acceptance of half a dozen.

No report on the outcome of this gigantic experiment has been made by the Shipping Board. Since, under the now changed conditions, the value of the ship-fabricating system depends on how it can maintain itself in commercial shipbuilding service, some notes on the practical working of fabricated-ship construction collected by representatives of *Engineering News-Record* are summarized here.

The "fabricating" system is characterized by the fact that the yard sublets to bridge-building shops the punching, shearing, planing, countersinking, scarfing, assembly riveting (so far as practicable within shipping limits), and in some cases the bending or curving of the plates and frames and other parts of the ships' hulls. This means that the work is done at a distance from the yard. It requires sending the necessary construction data from yard to shop by drawings or templets, or both, and obviously demands that the advance information be so precise that the parts will fit together when erected. Extensive changes in ship design, plant layout and construction methods have developed to suit.

Shipping Board Report on Method

So far as the Shipping Board's report (issued Dec. 1, 1918) indicates, the success of this new shipbuilding method is just as problematical as it was a year ago, for the subject is dismissed with the following remarks: "Summarizing the facts in connection with the fabricated ship, we find that the development of the structural steel ship and the enlistment, for the task of shipbuilding, of the engineering experience, the organizing ability, and the mechanical skill of the trades which built our bridges, our great office buildings and other commercial structures, may be counted upon to add from 3,500,000 to 4,000,000 tons of ships each year to our total.

"Three very significant facts should be noted with reference to this plan: First, if the yards had depended on their own fabricating shops and facilities it would have been impossible to develop an equal amount of new shipyard capacity for the manufacture of machinery and equipment, in two or three times the number of months required under the plan adopted. Second, without the ship-fabrication work and the ship equipment orders, hundreds of shops throughout the country might have been closed down, with immense losses to owners and employees. Third, the expense of new shop installations at the yards, if they had been built under the old system, would have run into hundreds of millions, and further concentration of the additional workers in the already overcrowded shipyard districts would have required many additional millions for housing."

Over $200,000,000 of public funds has been invested in the bridge-shop-fabrication system of shipbuilding, besides a large amount of private money. Exclusive of the latter item, the cost to date comprises $100,000,000 expended for shipyard plant and $100,000,000 or more for material and labor used in shipbuilding. The report of the Shipping Board from which these figures are deduced states that the ultimate expenditure for fabricated ships on present contracts will be nearly $500,000,000, so that with the plant cost a total investment of $600,000,000 will be chargeable to the fabrication system.

Quality of Work Excellent

All evidence obtainable testifies to the success of the fabricating method in point of quality of work. "The quality of the work is excellent; the possibility of delay constitutes the only danger of the fabricating system," says one yard manager. The results obtained at another yard are described by the statements of fitters and bolters of many years' service in old-line shipyards, that they have never handled steel that fits as well as the bridge-shop steel. An especially critical judge of shipbuilding matters, who spent many months in intimate daily touch with the work in a fabricating yard, states without reserve that "the work is superior to anything ever done in ordinary shipbuilding."

Curved Work Accurate—In some of the cases only the straight part of the ship is fabricated in the bridge shop, while in others molded and curved work also is done away from the yard. The quality of work appears to be independent of the large differences in system between the various yards, whose bridge-shop allotments range from 70 per cent. of the entire hull to 100 per cent.

The amount of altering or scrapping of bridge-shop-fabricated material has been negligible. As described by an experienced steel man now in shipyard work, the material does not contain many more field errors than ordinary viaduct work. One yard reports that during the construction of several ships not a piece was scrapped except for mistakes made in the yard itself.

Effect of Distance—Under present shipbuilding conditions fabrication is done at distances ranging from 5 to 1500 miles from the shipyard, yet there appears to be no effect of distance. Remote fabrication has been fully as successful as that done nearby. One yard had some of its best results, both in quality and deliveries, from the most distant shop of the several which fabricate its material. A concise summary of the effect of distance is found in the remark, "Fabrication at a distance is exactly the same thing as fabrication at the yard, except that the shop is 300 miles from the ways instead of 300 feet."

Distant Fabrication Does Not Complicate Erection—While many difficulties have developed in ship erection in the large fabricating yards during the year, it does not appear that these are chargeable to the system itself. It is, in fact, stated specifically that outside fabrication involves no greater erection difficulties or necessary costs than ordinary shipyard methods. Actual operations during 1918 have been affected by troubles of sequence of material and shortage of skilled labor to an extent that makes the erection performances no criterion of reasonable possibilities.

Conclusions on Cost Not Yet Possible

No present basis exists for comparing the cost of ships built under the outside-fabrication system with those built under ordinary methods. Main factors for comparison are the shop, transportation, handling and erection costs. Under the wholly abnormal cost, labor and urgency conditions of the past year, available figures are valueless for the necessary comparisons.

Concerning transportation costs: Some fabricated-ship contracts, let to shops located near steel mills, were based on fabrication in transit, so that the fabricated material arriving at the shipyard has no higher railway charge than raw steel shipped to the yard direct. In other cases the cost of shipment of steel to the bridge shop and thence to the shipyard has been several dollars per ton above that of direct shipment from mill to yard. It seems likely that under normal conditions the excess transportation charge, if any, would be negligible. Handling charges also should not differ materially.

Shop Costs Probably Favor Bridge Shop—So many factors bear on any comparison made between fabrication in a bridge shop and in a yard shop, that present contract prices throw little light on the matter. The fundamental element is the relative efficiency of the two kinds of plant. The past year's work has afforded opportunity for comparative judgments. Experienced shop managers state as a result of such comparisons that bridge shops are unquestionably able to work more economically than shipyard shops. For their normal production, bridge shops have been developed to a high degree of efficiency under keen competition, while no similar direct influence toward efficiency has been active in the case of shipyard shops. Men who have had occasion to study yard punch shops since the Emergency Fleet Corporation took over control of shipbuilding report that most of the shops could be greatly improved in efficiency by revising their layout, equipment, arrangement and operating systems.

Under present conditions, therefore, it appears probable that bridge-shop fabrication is about on even terms with yard-shop fabrication, taking into account the differences in shop efficiency and in amount of handling. It is assumed that the bridge shop is at the time in a position to do the shipwork without unbalancing its shop program or seriously lowering the load factor on part of its equipment, in view of the fact that shipwork makes use of only part of the equipment of a bridge shop.

The advantage of bridge shops having multiple and other automatic or semi-automatic punches, capable of doing most economical fabrication if the ship design permits their use, has been a factor in the past year's work. Its influence may be modified in future by the introduction in shipyards of multiple punches and semi-automatic punch tables, on an extensive scale.

Difficulties of Sequence in Getting Hull Material Due to Size of Operations

Serious difficulties have beset all the fabricating yards during 1918 with regard to the speed of building ships. These difficulties appear to have resulted partly from labor shortage and partly from irregularity in the receipt of fabricated material—in other words, the impossibility of getting hull material in sequence.

Though in the large yards steel has been piling up in storage since midsummer, yet in general the shipways have always been ahead of the steel supply. This meant not merely delay, but all the lack of system that hand-to-mouth living implies—and this under the worst kind of pressure for speed, the yard men explain. "The impossibility of getting material in sequence has brought a series of misfortunes in its train that no one who speaks plainly will deny," it is said. In part, perhaps, the sequence difficulties arose from the steel shortage, and in part from shop difficulties chargeable to the new character of the work. The abnormal scale on which the operations were conducted was the chief source of trouble, however. No reason has appeared for attributing the lack of sequence to the fabricating system itself. Under normal conditions and with the system worked on a normal scale, the difficulties should vanish.

Modifications of Ship Design

Practically all the fabricating yards have worked with simplified designs of ships. Simplification was thought necessary because of doubt as to whether bridge shops could do shipwork successfully. Allowance for the limitations, actual and fancied, of the existing shop equipment was therefore made by more or less radical simplification of lines and of structural details.

As a result of the past year's experience, many fabricated-ship men are coming to the belief that such simplification is not an indispensable thing with regard to feasibility or quality of work or its cost. Similarly, some of the large yards have virtually concluded that a large part of the templet making should be left to the bridge shop, and that detail drawings carefully developed in the drafting room are a satisfactory basis for fabrication.

Difficulties have arisen in the case of two yards through necessity for distributing their work among a very large number of individual fabricating shops. Uncoördinated deliveries have resulted from the distribution adopted, in a measure. It is now acknowledged that allotment to many fabricating shops offers a difficult problem.

Concentration of fabrication in a few big shops, to each of which large sections of a ship or entire ships could be allotted, has been decided upon in one case. Four inland ship-fabricating shops are being erected by the Emergency Fleet Corporation, of capacity 10,000 tons per month each, for this purpose. These shops will constitute an important basis for future ship-fabrication work.

Fourteen Points Essential to Establishing a Sound Railway Policy

By L. C. Fritch
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1. *Incorporation of Interstate Common Carriers under a Federal Act*
2. *Private Ownership and Operation*
3. *Federal Regulations and Control*
4. *Pooling of Traffic*
5. *Unification and Common Use of Facilities and Equipment*
6. *Regulation of Transportation Rates, Wages and Working Conditions of Employment by Interstate Commerce Commission*
7. *Uniform Accounting and Statistical Methods to be Prescribed by Interstate Commerce Commission*
8. *Federal Guarantee of a "Standard Return" to Meet Fixed Charges, Dividends and Surplus for Improvements*
9. *Representation on Board of Directors of the Federal Government*
10. *Elimination of State Regulation and Control in Interstate Commerce*
11. *Federal Control and Regulation of Capital Issues and Financing*
12. *Valuation of Property by Boards of Arbitration*
13. *Regional Directors to Supervise Operations*
14. *Standardization of Method and Practice in Railway Operation and Management*

TRANSPORTATION is the most important item of all the various economic problems confronting the nation. In direct proportion to the wise solution of this problem will be our future progress.

The "fourteen points" enumerated above, if intelligently and rationally applied to this question, will solve the problem in the interest of the public, the owners and the employees, the three most vitally interested parties. Any settlement which does not protect these interests equitably and fully will retard national progress and adversely affect the welfare of the people.

1. Federal Incorporation—The first essential to enable common carriers to perform their public functions is an allegiance to one master, the Federal Government, which makes necessary incorporation under Federal statutes. Experience has conclusively shown that the 49 regulating bodies existing at the present time have neither the inclination nor the ability to adopt a uniform and rational set of regulations. It is not possible for a corporation or an individual to serve two masters, particularly when each master prescribes conflicting rules, a compliance in one case being an offense in the other. Under such chaotic conditions no satisfactory results can be obtained, and the proper solution can only be found in Federal incorporation.

2. Private Ownership and Operation—This is to be preferred to Government assumption of these functions, for the reason that a government has in the majority of instances completely failed to operate any enterprise efficiently, unless it may be a political machine. The nation at this time is not prepared to assume the financial burden which acquisition of ownership of some twenty billions of property would impose upon the people, in addition to the war debt, and if the operation of the railways is placed in the hands of the owners, and proper and sound public regulation is enforced, the results will be more satisfactory than could possibly be secured under Government ownership and operation. Proof of this fact is abundantly available. To be convinced of this truth it is only necessary to investigate the mistakes Canada has made in its railway policy.

3. Federal Regulation and Control—These are most essential elements in the proper solution of the future railway policy. The assumption of the control of railways during war time has demonstrated the necessity and wisdom of such action. While many things are done under war emergency measures which, in peace times, would not be necessary, yet the peculiar interests of the owners must be directed and controlled, and this can only be done by the supreme authority of the Government, which should rule for the benefit of the public as a whole and control the selfish purposes of the individual, be it a person or a community. Federal regulation and control will act as a governor to private ownership and operation, but it must be absolutely divorced from all political affiliations.

4. Traffic Pooling—The pooling of the traffic of the country among the railways will produce the most economical results and efficient service. It will move the traffic over the shortest and most economical routes, will prevent congestion and insure each carrier a fair proportion of traffic, resulting in a scientific use of the railways in the interests of the best service at the lowest cost. The most pernicious and destructive competition will be thereby eliminated, through cutting out unnecessary and duplicate service, resulting in reduction in cost and improved service otherwise unattainable. The repeal of laws now prohibiting the pooling of traffic is, of course, necessary. In effect, this law has been suspended during Federal control of the railways, with most excellent results. Under future Federal regulations the law should be repealed, if the public is to de-

give the benefits of the economies already secured in this respect during Federal control. Service will still be the controlling competitive feature, which will be an incentive for efficiency in operation, and the best service at the lowest cost will inevitably result. The weaker lines must be compensated fairly in the division of traffic to enable them to give adequate service to the territories which they traverse. This is not a difficult matter and can be equitably adjusted.

5. *Unification and Common Use*—Federal control of the railroads has accomplished excellent results in the unification of terminals and common use of tracks, equipment and other facilities. Such results were impossible under private control, due to the selfishness of the individual roads, regardless of the benefits such use might be to the public. The duplication of expensive terminals, trackage, equipment, etc., has resulted in capital expenditures of millions which might have been avoided under a sane policy of regulation and common use. There is no field in the operation of railways more fertile of results—economical and beneficial alike to owners of the railways and the public—than the unification of terminal facilities, trackage and equipment and their common use under fair regulation, but it will require the supreme authority of the Government to make it effective and overcome the prejudice of the individual owners, which has been the means of preventing such consummation under private control.

6. *Regulation by Interstate Commerce Commission*—It is eminently unfair to hold that the Interstate Commerce Commission has entirely failed to perform its functions. As a regulating body it has performed eminent service to the public in the prevention of discriminations and favors to certain classes of shippers, and by these very means has performed the valuable service to the carriers in "protecting them against themselves." The carrier retained the revenues which before the days of the Interstate Commerce Commission were largely dissipated in refunds and rebates to favored shippers. The commission, by its regulation of rates, has given the public the lowest cost of transportation of any country in the world, and has thus fully justified itself as a public body. On the other hand, it may be claimed that the result of this extreme policy has reached its limit, and must be reflected in decreased transportation facilities and impaired service, due to the inadequacy of these rates to produce sufficient revenue to enable the carriers to perform their public function properly.

The duties and responsibilities of the commission should be enlarged to cover, not only the income, but the outgo of the carriers as well, to the end that sufficient revenue will be derived to meet the necessary expenditures of fixed charges, reasonable return on investment, operating expenses, and a surplus to provide necessary improvements and extensions. Granted these enlarged duties and powers, the commission will be alike responsible to the public, the owners, and the employees, and it will be in a position to demonstrate its usefulness and, if properly constituted, will amply justify its existence. The commission cannot be held responsible for its inability to secure results which it was powerless to secure under the laws regulating its duties. The proper solution lies in granting it the necessary legal powers to perform its various functions and then in holding it accountable for the results. If thus constituted, it will not be found wanting. The fixing of wages and working conditions of employees engaged in transportation should be controlled by the same body that prescribes the revenues of the carriers. The highly specialized departments of the commission should have charge of these important matters and alike protect the interests of the employees, the public and the owner of and investor in railway securities. Under present conditions, the operating heads of railways devote a large part of their time to negotiations with labor organizations over wage schedules, working conditions and grievances, leaving little time to be devoted to the legitimate duty of running their business. This should be corrected and the matter handled by a competent technical body, skilled in such matters, with time to devote to them and reach equitable conclusions which will be stable and satisfactory to the interests involved.

7. *Uniform Accounting*—The Interstate Commerce Commission has performed a valuable duty in prescribing a uniform system of accounting for common carriers, and while modifications of the existing system are desirable, it has produced greater reliability in operation and more confidence in the carriers, and has in this respect performed a service of inestimable value to both the public and the carriers. In addition to the system of uniform accounting, there should be prescribed by the commission a uniform method of reporting statistics covering the various operations. This is a necessary adjunct to the accounting system to enable the true results of operation to be reflected.

8. *Federal Guarantees*—The Government operation of railways under war-time conditions has been the means of saving from bankruptcy the majority of the companies taken over. It would have been impossible for many of these companies to pay the high costs of wages and material entering into operations during the war, and meet their financial obligations. The Government has performed a great public service in thus protecting the roads against the calamity which confronted them, and its duty will be fully met if the roads are retained under Government control until the proper adjustments in economic conditions have been made to enable them to carry their own burdens. A return of the roads to private control before that time would be a public calamity.

Under Federal control, the law provides that the carrier shall receive as compensation a "standard return" equal to the average annual operating income during the three years which ended June 30, 1917. In the case of the strong roads, this amount is generally sufficient to meet fixed charges, a reasonable dividend, and a surplus to finance necessary improvements and extensions. In the case of the weaker roads, however, this standard return is not sufficient to meet financial obligations. Some of the so-called "weaker" lines have made requests for additional compensation which have good and reasonable grounds for consideration, and in the interests of the public should be allowed, to enable these roads to discharge their financial obligations. It would be disastrous to have a number of these roads default in their payments at this time, and the Government owes it as a public duty to the communities served by these lines that they shall remain solvent corporations.

The proper policy to protect the transportation industry must make provision for the so-called "weaker" roads; they serve various communities which depend upon them for their existence. It is a Governmental duty to preserve these properties and aid them in such a manner as will enable them to exist and perform their functions properly. This can be done by guaranteeing a standard return to such companies sufficient to enable them to meet their financial obligations, paying the operating expenses, fixed charges, a reasonable return on the investment, and expenditures for improvements and extensions, all to be done under full Government regulation and control. The stronger lines might by an equitable plan assist the Government in meeting such obligations.

9. Government Directors—Government regulation and control makes necessary a voice in the management of the properties, and to this end adequate representations on the boards of directors is essential. The policy of selecting able representative business men to act for the Government in such capacity would result in business management of the railways in the interests of the public and would have a wholesome effect in railway administration.

10. No State Regulation of Interstate Matters—The regulation of common carriers by the various state commissions has resulted in confusion and increased cost of transportation, without any direct benefit to the public. There are certain functions which must be regulated by the communities, such as police powers, health regulation and questions of purely local character. These should be delegated to municipal and state authorities, but the broader powers, which affect interstate commerce, should be regulated by the Federal Government alone. At present there are 49 regulating bodies having jurisdiction over railway operation, and in no two states are the regulations the same. Indeed, the rules in some states conflict with those of an adjoining state, and in many instances what may be required in one state may be strictly prohibited in another. This could be regulated in a uniform manner by one authority—the Federal Government—with equal justice to all. There is scarcely a state-made rate which does not affect interstate rates—therefore it is the function of the Government to regulate interstate commerce without discrimination or favor to any community or person. This cannot be accomplished under state regulation. The first essential, therefore, to a uniform policy of Government regulation and control is to abolish state regulation and concentrate this power in the Federal Government, for the benefit of the whole people.

11. Federal Control of Financing—There may have been cases of flagrant violation of the rules of propriety in the issuance of railway securities in the past. There is no defense for such action and no apology can be made for it, but, because isolated cases have existed in the past, and because a limited amount may have been irregularly issued, is it fair to condemn the entire railway security issues? The proper solution of this problem is so to regulate railway financing and capital issues in the future that it will be impossible to continue the abuses of the past. This would restore public confidence in such investments and enable the roads to secure capital for improvements and extensions.

12. Valuation by Arbitration—The proper Government regulation and control of common carriers makes necessary a consideration of the value of the respective properties. It may be desirable to consolidate certain properties or operate them in common, which calls for data as to the value of the properties involved. The physical valuation of the railways being made by the Interstate Commerce Commission is promised in 1920 or 1921. This may, in many cases, be too late for the purpose of carrying out a general railway policy. Much doubt is expressed by railway owners as to the valuation which the commission will finally place on their property. This will result in lengthy litigation, to which the roads will resort, unless an agreement is reached. It would seem more desirable to submit the question of valuation to impartial boards of arbitration, which would reach results more quickly and with justice to all concerned.

13. Regional Operating Directors—Numerous suggestions have been made to apply the experience gained in the organization of the Federal reserve banking system to the regional control of railways. Seven regions have been created, each in charge of a regional director. The objection to this system is that it results in a centralized control, from which authority must be obtained governing the details of operation. Such a system will not produce the most efficient results, as it takes away from the direct operating heads of the various properties the initiative resultant from complete authority over the details of operation.

A system of regional boards of governors similar to those in the Federal reserve banking system would produce better results than the present scheme of centralized control over operations. The boards should act in an advisory and supervisory capacity only, leaving the details of operation and responsibility in the hands of the active managers of the respective properties.

The transportation business requires prompt action and will not brook the delay incident to appealing for authority to a central source, except in matters of policy. The man on the ground should have the authority to act on his own responsibility. With it he will secure results.

14. Standardization—Transportation is of a similar nature all over the country, and while the conditions under which the operations are conducted vary in different sections there are numerous and various practices and methods followed to obtain the same results within the same territory.

There is one method of obtaining a certain result which is better than every other plan, and on almost any railway system there are certain methods and practices used to obtain certain results, which methods and practices are better than those used on other roads. Experiments are costly, and much time, money and energy are needlessly expended. This could be avoided by utilizing the experience of others.

A committee or committees on the standardization of methods and practices in railway operation and management could save millions of dollars annually in the operation of our railroads, if the standards formulated were put into practical effect. These results can be secured through the means of regional boards having broad powers over the railways, all working to a common purpose, "The best service at minimum cost."

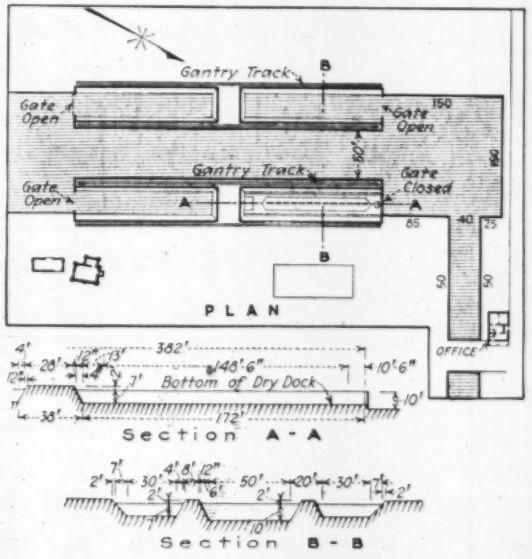
Build Boats in Dry Docks at New Yard in Detroit

Concrete Barges Under Construction on Concrete Floors Inside Dikes Which Will Be Flooded for Launching—Lighters Carry Construction Machinery Alongside Dry Docks

CONCRETE barges for the New York State Barge Canal are being built at the new yard of the Grayhaven Shipbuilding Co., on the Detroit River, Detroit, Mich., in a yard which contains many original features, the most important of which is the use of dry docks in which to build the barges. There are at least two building docks in this country for large ships, but the design of an entire shipyard around a series of dry docks is entirely new, so far as the records show. The yard is intended to be a permanent undertaking, though at present it is being devoted entirely to the construction of five concrete barges for the United States Railroad Administration.

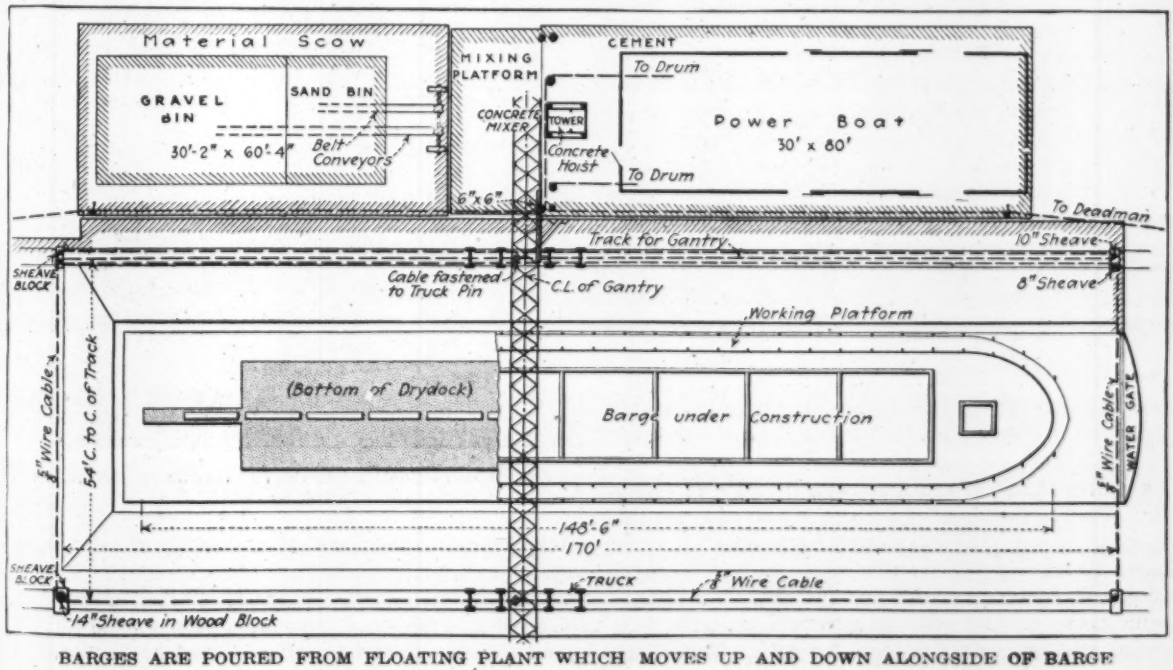
The site of the yard was a real-estate development, the main feature of which was a lagoon 150 ft. wide extending up from the Detroit River, which is about 2000 ft. away. This lagoon was connected by a cross canal to a similar lagoon also extending to the river, it being the intention to sell building lots with water frontage on the whole site. No houses had been built at the time it was taken over last July. The dry docks of the new yard have been built out into the lagoon, and the waters of the lagoon will be used not only to float the completed barges out to the river, but also to carry lighters and barges bearing the construction material and plant. Connection is also established over a bridge across the connecting canal between the lagoons, so that the yard may be reached by trucks and wagons.

The first step toward constructing the dry docks was to throw up a continuous dike about 382 ft. long at a distance of some 50 ft. from the shore of each lagoon, and then to cut in two the basin so formed on each side, with a cross dike extending to the shore. This formed four basins, as shown on the plan, two opening toward the shore and two toward the river. The bottom of each basin was then paved with a 5-in. thickness of concrete; the side slopes of the dikes were smoothed off but left unpaved, and gates were placed across the opening of each of the basins. Four dry docks were thus formed,

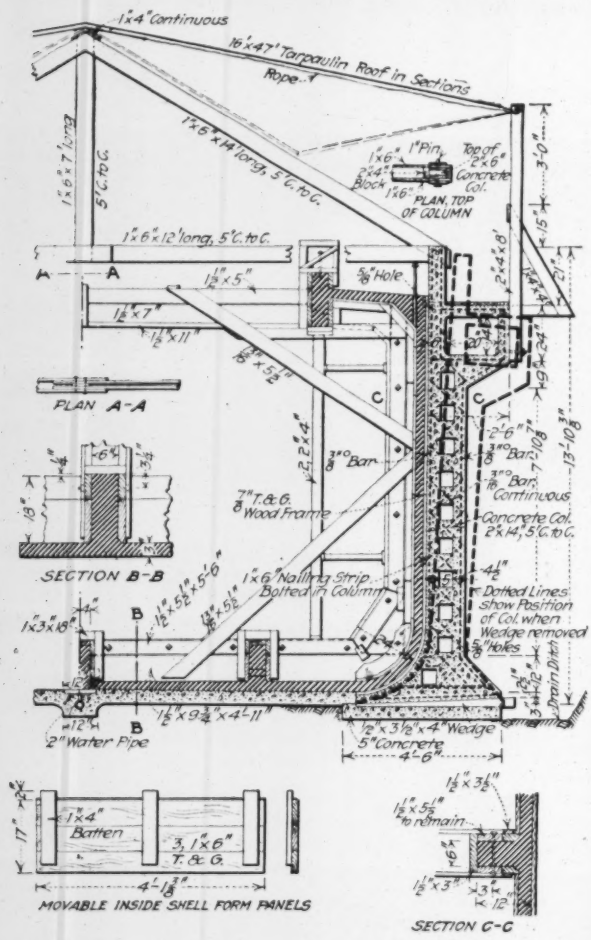


FOUR DRY DOCKS ON LAGOON MAKING IN FROM DETROIT RIVER ARE WAYS FOR BARGES

having a depth of 7 ft., a total inside bottom length of 172 ft., and a bottom width of 30 ft. The main lagoon was then dredged to a depth of 10 ft. For the time being the gates consist merely of earth dikes which will be dug out when the water is to be let in under the



BARGES ARE POURED FROM FLOATING PLANT WHICH MOVES UP AND DOWN ALONGSIDE OF BARGE



CROSS-SECTION SHOWING FORM DETAILS IN BUILDING CONCRETE BARGE

boats to be launched, but it is intended to have permanent gates, of stop logs, which can be readily removed and replaced.

The concrete barges now being built in the yard were described in *Engineering News-Record* of Aug. 8, 1918, p. 271. Each boat is 150 ft. long, of 21-ft. beam, and 12 ft. deep. It is of simple type, with frames 5 ft. on centers, a 3-in. shell and an open hatchway crossed with deck beams every 15 ft. The bottom is flat, except for a 2-ft. quadrant curve at the bilge, but both bow and stern have framed lines.

Many innovations have been introduced in the construction of the barges. The principal points of interest are the use of precast concrete frames to carry the outside forms, a hydraulic pump device to give the completed barge an initial lift so that water can get under it for launching, the gantry crane control for the ways, and the use of floating equipment for the concrete mixing and placing.

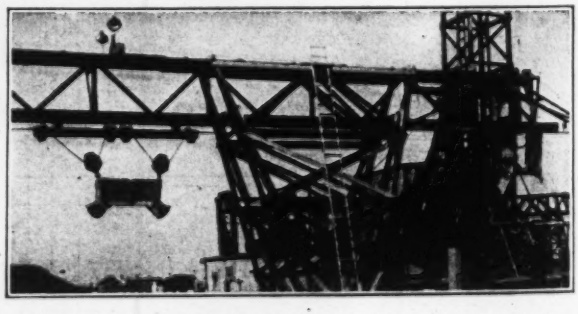
As shown in one of the drawings, the outside forms of the straight section of the barge, which compose the greater portion of its length, are made up of tongue-and-groove lagging which spans concrete jack columns spaced 5 ft. center to center and fastened with removable hooks to eyes let into the depressed concrete floor running along the outer edge of the dock. These jack frames are of precast concrete, with openings to save weight and also to provide spaces for trestle beams. They are 2 x 14 in. in normal cross-section, and are reinforced with $\frac{3}{8}$- and $\frac{3}{16}$-in. steel, as shown. Each frame has an extension at the top to carry the working platform, and has also a sloping bottom which is wedged up from the dock base. The outside forms—that is, the tongue-and-groove lagging—are carried as a continuous section for the entire straight length of the barge, about 120 ft.

This lagging is tacked to a 4-in. wood strip held to the concrete frame by bolts through holes left there for that purpose. Spaced on 1 ft. 8 in. centers between the frames are vertical intermediate 2 x 4's, supported directly on the dock bottom and intended to give additional bracing to the outside forms. The outside form of the bilge curve is made up of small slats laid longitudinally and coming flush at the lower end with the top of the concrete floor of the dock. The bottom of the barge is poured directly on this concrete base, which is oiled or soaped to insure easy removal after the concrete has set.

The outside jack frames also carry at their top a light truss which serves the double purpose of cross-bracing the frames and of carrying the inside forms. From the outside of the working platform there rise posts which carry, with the aid of the center post of the cross-truss, the tarpaulin roof which must be ready, according to the specifications, in case of wet or extra cold weather during the continuous pouring of the barge.

The outside forms between the beginning of the end curves are removed as one piece by the knocking out of the wedges under the jack frames. Thereby each frame is let drop 2 in. at its outer support, which means about 7 in. away from the concrete at the top of the shell. Once away from the shell, the whole side form is slid back along the concrete floor of the dock, until it is well out of the way. When a new barge is built the whole thing is wedged up again and pushed into proper position.

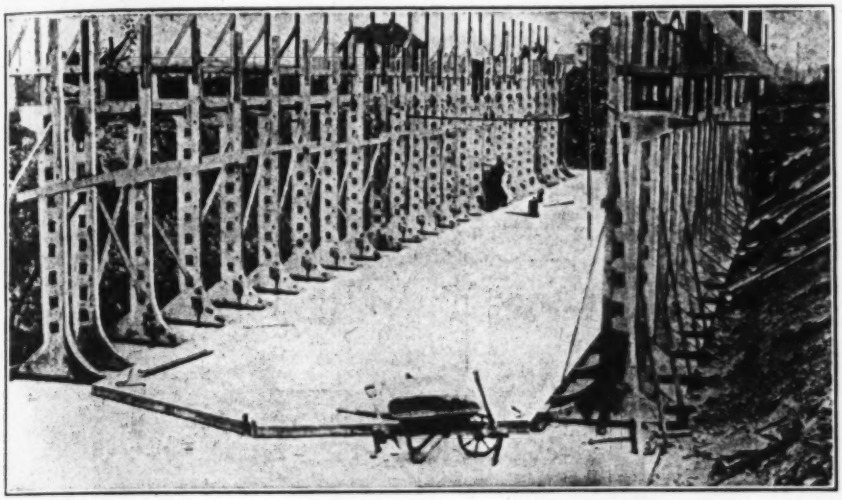
The end forms for the barge are of mortar molds. The stern, which is of somewhat complicated curvature, is in three sections divided along vertical lines. These three sections were set up in a shop with the frames

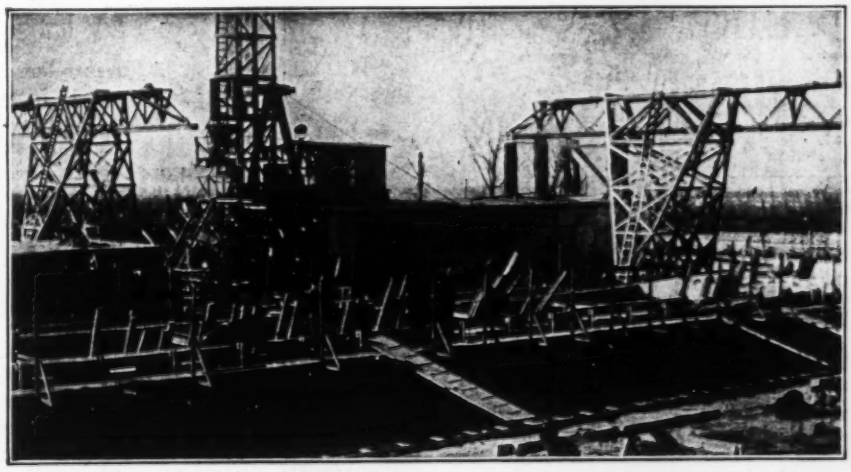


TWO-ENDED BUCKET DEPOSITS CONCRETE IN BOXES INSIDE BARGE

of timber cut to templets and a sheeting of wire mesh tacked to the proper curvature in each section. An interior and an exterior layer of mortar were then plastered onto the metal, forming a perfect mold for the curve. These forms were then blocked up on the con-

crete bottom of the dock and slid into proper place. When the section is cast they are dropped with wedges and slid out in three sections. The bow has a one-way curvature above the bilge curve, and this upper section was formed with the regular ⅞-in. tongue-and-groove material bent around wooden frames cut by templet to proper curve. Below the bilge curve, where there is double curvature, due to the turn of the stern and of the bilge, a mortar form similar to that employed at the stern was used.





CONCRETE JACK FRAMES ARE FIRST SET UP ON CONCRETE FLOOR OF DOCK TO CARRY FORMS FOR CONCRETE BARGES — WOODEN GANTRY CRANES RUN OVER BARGES UNDER CONSTRUCTION AND DEPOSIT CONCRETE FROM ADJOINING FLOATING PLANT

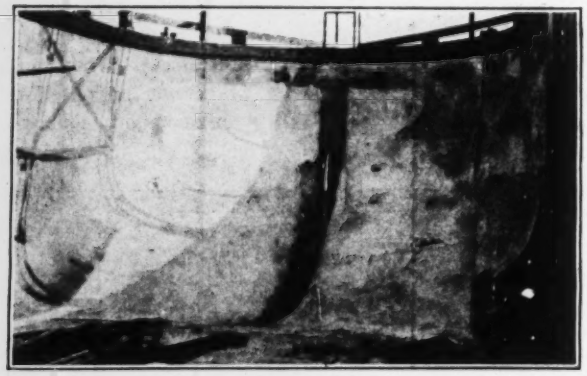
The inside forms are thoroughly cross-braced, but are supported by small concrete pieces blocked up on the steel of the floor. The floor has no top form, of course, a proper thickness being screeded off level. The floor frames—that is, the keelsons and the cross-frames—are in boxes between the keelsons and the frames, and the connecting joints are nailed to the keelson box and screwed to the frame box, so that in dismantling wood screws can be readily taken out and the whole box slipped out. The forms for the side frames are heavy 1½-in. timbers held in place by cross-bracing attached to the bottom frame and to the hatch girders. The design of the barge calls for a wooden strip alongside of each frame, to be used as a nailing strip for the wooden sheathing of the barge. In the design of the forms for the Detroit yard the frame forms are in two pieces—the outer piece, 1½ x 5½ in. in section, being bolted clear through and left in place as the nailing strip for the sheathing. The inner piece, which is 1½ x 3½ in., forms a piece of the inside shell form and is removed when forms are dismantled.

Provision is made for concreting each of the barges from a dump bucket carried on a gantry crane traveling up and down over the barge. As shown on the drawings, on the top of each dike there is a 2-ft. industrial track. Traveling on this track, continuous along both docks on the same side of the central lagoon, is a timber gantry crane, one for each side of the lagoon. One of the views gives an idea of the appearance of this crane. It has an extending cantilever arm which reaches out over the water side of the dock. When the barge is to be poured the floating mixer plant, consisting of a power boat and a material scow, is brought immediately alongside of the dry dock and is fastened to the outside truck of the gantry crane by a heavy timber frame, so that any movement of the boat parallel to the dock communicates a similar movement to the gantry crane. In order to insure the parallel motion of the crane during any such movement, there is a continuous ⅝-in. cable running along the center of each track and around sheaves across the end of the dock. By the same mechanical motion which controls the well known drafting machine devices, the crane is thus kept moving parallel up and down the track over the barge whenever the material boats are moved up and down alongside of the dock, by hauling on lines to dead men at either end of the floating equipment.

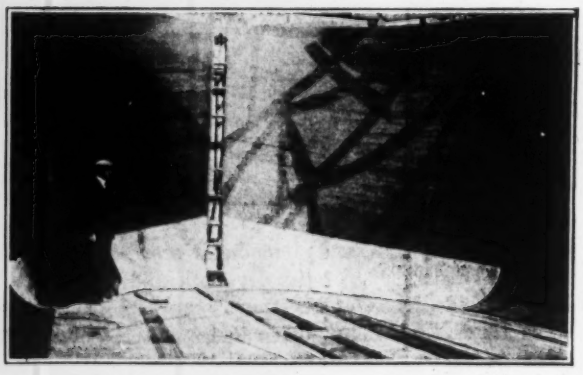
In concreting, then, the operation is as follows: The

material scow, which is a wooden scow with bins let down into the deck, and has belt conveyors running under these bins to the end of the scow, is first filled with enough material to make the run and is lashed tight to the power boat. This, besides carrying the heavy engine equipment for all removing and mixing operations, has an apron with the concrete mixer extending out toward the material scow. Just inside the mixer is a concrete tower with an elevator bucket taking material from the mixer. The mixer and material scows are then fastened alongside of the dock with the gantry crane so that its traveling cross buckets can run on the extended arm directly under the spout of the elevated hopper. Material is fed to the mixer through the belt conveyor, and is mixed and carried up to be dumped into a double-mouth bucket which traverses the beam of the gantry and, controlled by the engineman on the power boat, is lowered into the barge.

Concreting is carried on from two ends of the boat simultaneously. After enough concrete has been dumped



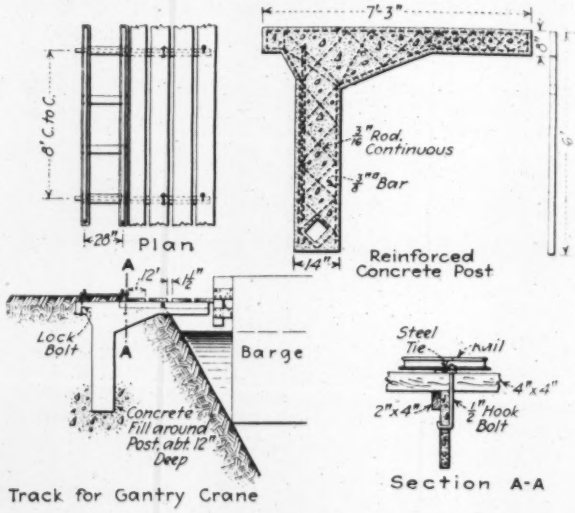
MORTAR MOLD FOR STERN FRAME IS IN THREE PIECES



BASE OF BOW FORM IS MORTAR MOLD

in the boxes at one end of the boat to keep the placers busy, the whole equipment—that is, the scow, the power boat and the gantry—is moved back to the other end of the boat, and the concrete is deposited there. Mixing the concrete and getting it to the boat are not the controlling operations in concreting a barge. The prime difficulty lies in getting the concrete into the narrow forms so that there is ample opportunity for the moving operations, without delaying the placing at either end of the boat.

An interesting detail in connection with the gantry crane is the small precast concrete frames which carry the track for the crane on the dike side. On the inside, it will be noticed, the tracks are on the original ground and do not require additional support, but over



GANTRY TRACKS ARE SUPPORTED ON PRECAST CONCRETE POSTS

the dike it was thought better to provide some extra base.

This has been taken care of by the use of inverted L concrete frames 14 in. wide in the shaft and 2 in. thick, with an extending arm carrying the wooden plank runway which extends out to the concreting barges. These frames are footed in concrete piled around the base and are spaced 8 ft. on centers. They carry longitudinal 4 x 4's on which the steel ties rest.

The final novel device is the lifting arrangement of the barge. It will be seen from the cross-section that the only buoyancy the completed barge will get when the water is let in is the lift under the bilge curve. This is not sufficient to float the boat. There is, therefore, provided along the center line a groove 2 x 12 in. in dimensions in which are set wood planks 9 ft. long, with slot spaces between. Under this groove is a continuous pipe with ¾-in. nipples rising up under the plank every 10 feet.

When the boat is to be launched water pressure is put on this pipe, which lifts the plank, and thereby raises the barge a sufficient height to allow the water to run under the barge and give flotation to the vessel.

The Grayhaven Shipbuilding Co., which built this novel yard and has the contract for the five New York State canal barges, has for its principal members Thomas E. Currie, a well known Detroit concrete contractor, and Edward Gray, engineer. Mr. Gray has recently been connected with the Ford Motor Co. in the capacity of construction engineer.

Other details of the concreting operations at the plant will appear in an early article which will compare the methods in use at four yards building the New York Canal barge.

Routing of Fabricated Ship Material at Bristol

Hull Construction Operated on Basis of Shop-to-Storage-to-Ship System Requires Accurate Timing of Material Supply, Shop Work, and Assembly—Routing Handled by Production Department

MAINTAINING coördination of material supply and shipbuilding, which has proved to be one of the key problems in high-speed shipyard work, is effected at the Bristol, Penn., yard of the Merchant Shipbuilding Corporation by a storage and routing system worked out to suit the plant operation. It is administered by a production department, separate from the technical and operating branches of the yard organization. The machinery of the system is simple, but it works effectively.

With material fabricated in distant shops, it has been found impossible to assure precise sequence of delivery at the yard. Incoming fabricated ship parts cannot be sent directly to the shipways, and therefore coördination of supply and consumption must be obtained by storage intermediate between shop and ship. The advantages of working through storage are so marked, moreover, that this system is applied at Bristol to the entire operation of the yard, including the punch shop and the steam engineering and equipment departments. In other words, the shop-to-ship system favored in the conventional yard practice of former days is eliminated throughout, just as it has been eliminated in all shipyards during the past two years so far as miscellaneous ship equipment is concerned.

Large storage yards for hull material, and storehouses for machinery and equipment, have been provided at Bristol to act as equalizing reservoirs. These, with a system of ordering, routing and handling between shop storage and ways, control the flow of material. The system as used for hull material is described herein, but substantially the same procedure is applied to the other parts of the yard work, as the handling of machinery, rigging and equipment.

Special pre-assembly facilities and space for finished storage have been found necessary to the best working of the Bristol yard. They aid in placing all operations preceding the hull erection upon a manufacturing basis in which the several units can work without mutual interference and delay.

Functional Conditions—Half a dozen different classes of material involved in the shipbuilding work had to be provided for in the operating system.

1. Fabricated material arrives from distant bridge shops, ten or more in number. These shops punch, scarf, countersink—and, to a certain limited extent, assemble and rivet—about 83% of the tonnage of the hull. Much of this material is ready for erection, but some must undergo further working in the yard shop. None of the material can go direct to the shipways, as it does not arrive at the exact moment when it is required and as the incoming cars contain material for several different ships. Therefore it must be delivered to storage—for unloading, sorting and marking with the proper erection marks—and piled where it will be instantly available.

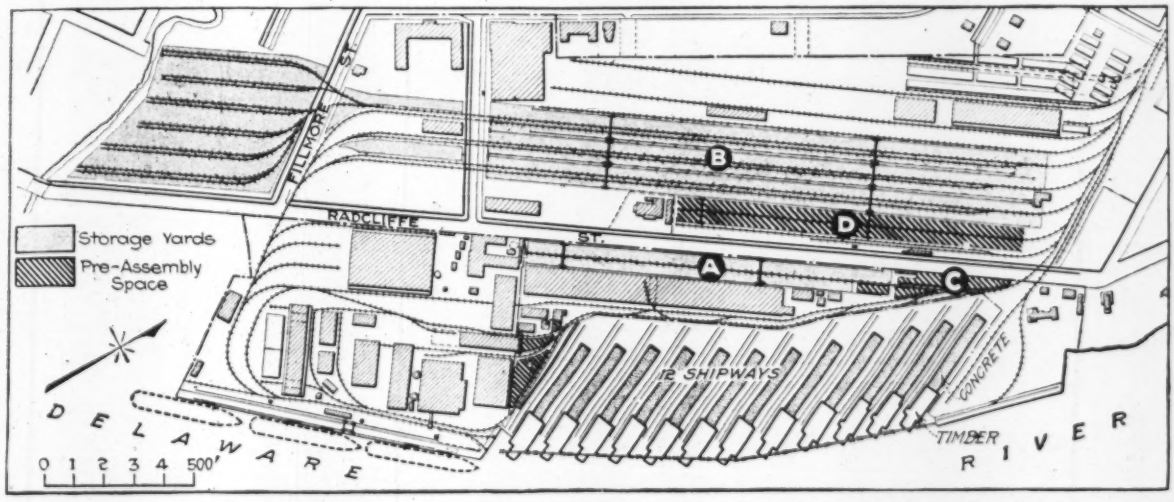
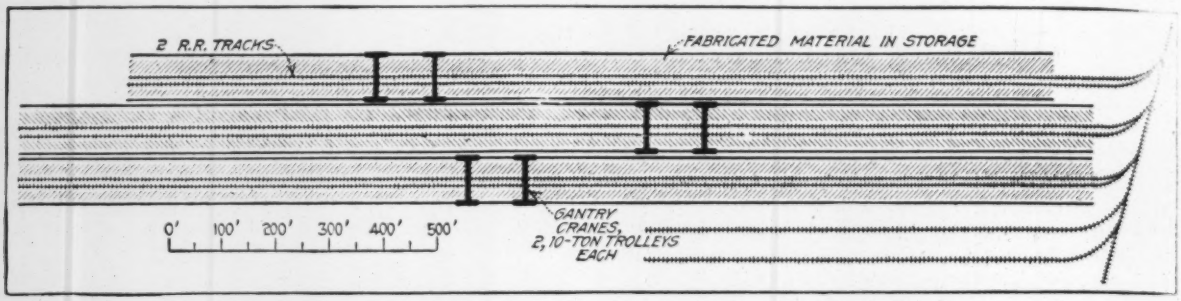


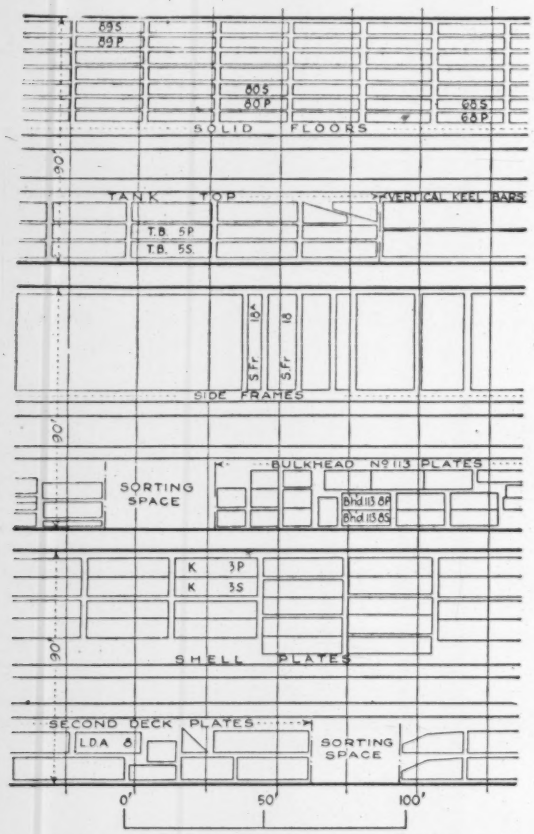
FIG. 1. LOCATION OF STORAGE AND ASSEMBLY FOR HULL MATERIAL AT MERCHANT YARD

2. Bridge-shop material requiring further work in the yard shop includes such parts as shell plates for the molded body, which must be rolled, and floor frames for placing forward and aft of the middle body, which require the shaping and riveting on of bent bottom angles. This material, drawn from main storage as the shop routine requires, must return to storage after final fabrication, as the work in the shop does not coordinate with that on the building berths.

3. A large amount of raw steel is required for the yard fabricating shop. This is stored close to the shop and kept apart from storage for fabricated material.

4. Most of the yard shop production is made from templets, and is fabricated on stock so that erection need never be held up by shop delays. When fabricated the material is in the same relation to the yard as incoming bridge-shop material, and, like the latter, goes to the main storage.





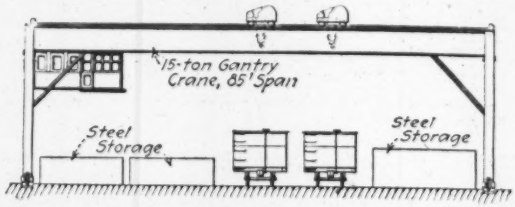


FIG. 2. CROSS-SECTION AND PART PLAN OF STORAGE FOR FABRICATED STEEL

5. A certain number of parts must be "lifted" from the ship. These, of course, require to be put through the shop without delay when the berth requires them. Storage is not involved.

6. Pre-assembly of fabricated material has undergone very great development at Bristol during the past year. It now includes possibly 25% of the total weight of the hull. Assembly of parts such as web frames, floors, stringers, girders, etc., has been carried on from the beginning, but in the expansion of the work deck houses and bulkheads were assembled complete, and assembly has been applied to the entire keel, the fantail, and some special groups such as the bow section of the keel with its frame. The material to be assembled must be drawn from storage, in order to keep the assembly work independent of the shop routine. The smaller assembled parts return to storage, while the larger units are held in the assembly space until needed by the ship.

Storage and Assembly Yards—The main elements of the storage system are a raw-material yard directly adjacent to the plate and angle shop, and a large main storage yard for fabricated material. The latter has recently been extended southward, and a section for storage of pre-assembled parts thereby provided. The two main yards are located as indicated by the letters A and B in the sketch plan, Fig. 1. In each, material is handled by traveling gantry cranes, and the yards are therefore arranged as narrow, long bays corresponding to the craneways, 95 ft. wide. The raw-material storage consists of a single bay, while the fabricated-material storage has three bays side by side. Two railway tracks extend down the middle of each bay.

Flat piling is used in the main storage yard. The arrangement of this yard is indicated by the section and part plan, Fig. 2. A separate piling space is allotted to each special piece in the ship; these spaces measure about 20 ft. along the bay and 30 ft. transversely. The storage for assembled material, at the south end, is arranged like that in the northerly part of the yard.

Timber sills laid on the ground are the foundation for the piles of steel. In the plate portion of the yard a few racks have been set up, but in general the rack system was distinctly discarded when the yard was planned. The raw-steel yard is arranged in the same way.

A governing feature in the arrangement of the piling sections in the main yard was the erection schedule of the ship, which fixes the sequence in which the pieces are erected. The piling sections, beginning at one end of the yard, were arranged approximately in accordance with this erection schedule, so that picking up pieces and sending them to the shipway could be done as nearly as possible by a slow, progressive movement of the crane along the length of the yard during the shipbuilding period. The six cranes of the three storage-yard bays correspond to the 12 shipways, with two ways at the same stage of erection.

An important element in the working system is a space for working storage at the head of each shipway. This space is about 50 ft. square, and racks and sills have been placed in it. Originally, the intention was to do some pre-assembly work in this space; parts delivered from storage to the ship were to be stowed under the crane trestles between the shipways. But stowage

MAIN PRE-ASSEMBLY YARD AT BRISTOL IS COVERED BY GANTRY AND SERVED BY TWO RAILWAY TRACKS

under the trestles has been found less convenient than using the head of the way for the purpose.

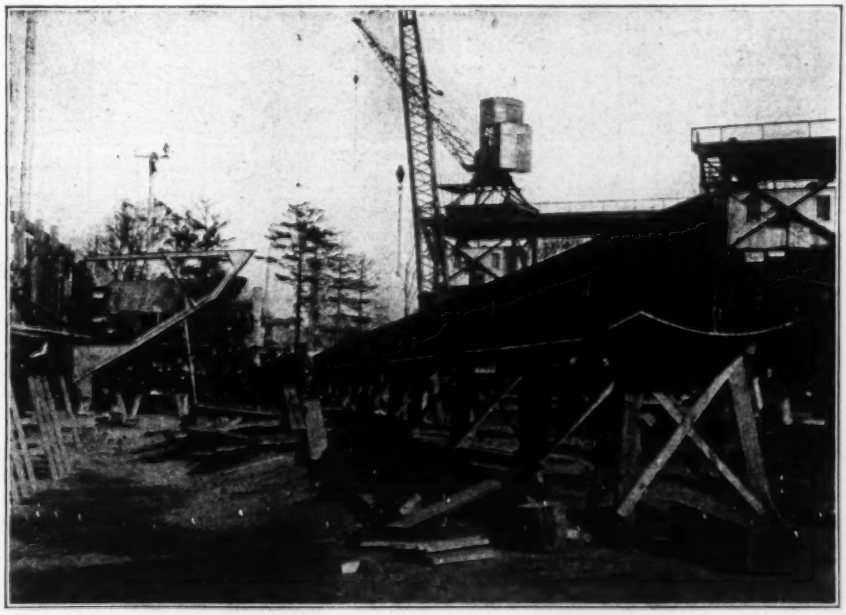
Assembly work was at first provided for by turning over to it a triangular space north of the raw-steel storage, marked C in the sketch plan, Fig. 1. Subsequently it was found necessary to turn over to this work a large area forming the continuation of one of the bays in the main storage yard, as marked by the letter D in the plan. A view of this space is shown by Fig. 4. Crane service is provided by a gantry like those of the storage yard. Compressed-air outlets are arranged along the sides of the supply tracks along the middle of the bay. Assembly of small parts is facilitated by the provision of two Hanna compression riveters under a shelter roof near mid-length of the yard. Other assembly riveting is performed by air hammers.

Deck-houses and bulkheads are assembled entire. The most distinctive novelty of pre-assembly at Bristol is the riveting up of keelson and flat keel plates in continuous lengths of 70 to 100 ft., these lengths further being fitted together and the splices reamed before the sections are taken to the shipway. This is done in the assembly space marked C.

Here also the bow section of the ship is assembled with eleven pairs of frames to form one erection piece.

Erection Schedule Governs—Planning the sequence and timing of all parts of the work, on the shipways and in the shop, was governed by an erection schedule to which the berth work is required to conform. The schedule was made out early during the past year, in conference between the different departments concerned. Thereafter all orders for the bridge shops were timed correspondingly, the storage yard was laid out in the erection sequence, and all work in the shops and on the berths was made subject to the same schedule. A small part of the schedule diagram is reproduced in Fig. 5.

As this diagram indicates, the units of the schedule



FULL-LENGTH KEELSON AND FLAT KEEL ASSEMBLED ON HORSES

are not individual pieces, but "erection groups." These are lots of material equivalent to approximately a carload each, required at substantially the same time. These erection groups are the items by which the shipway places orders for steel with the storage yard.

Adjoining each shipway is a production clerk's office. Here is kept on file a complete set of Material Order sheets (Fig. 2), covering the successive erection groups

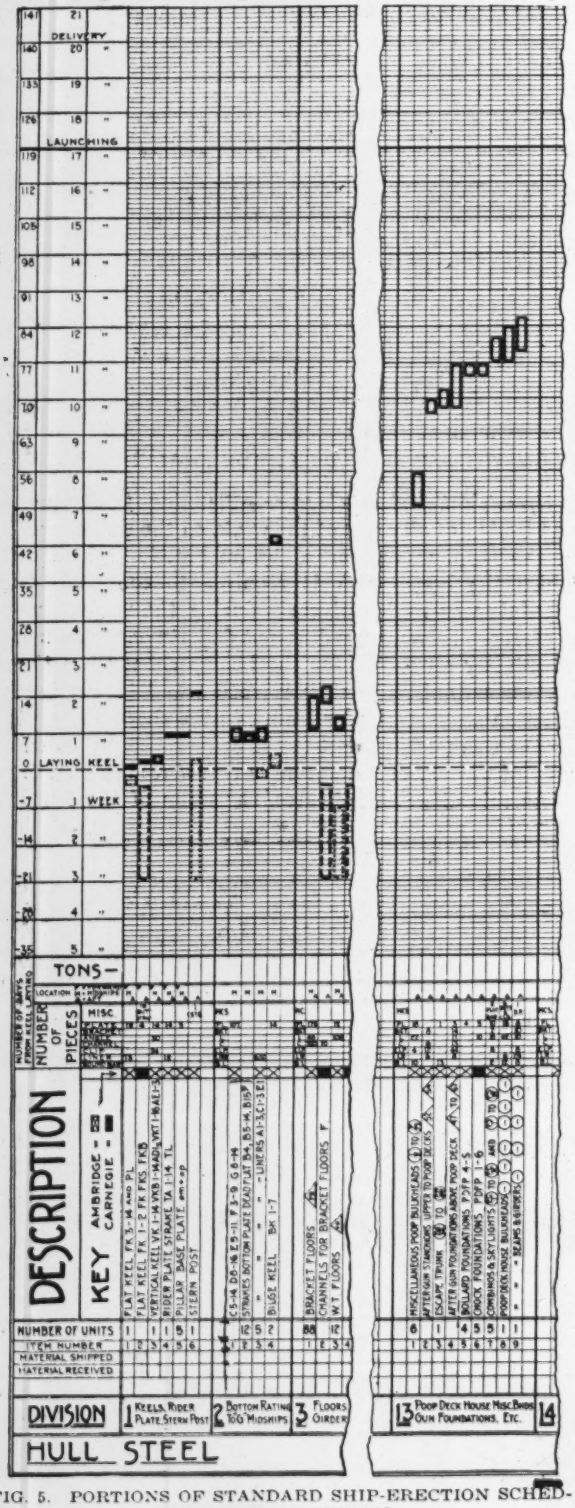


FIG. 5. PORTIONS OF STANDARD SHIP-ERECTION SCHEDULE USED AT BRISTOL

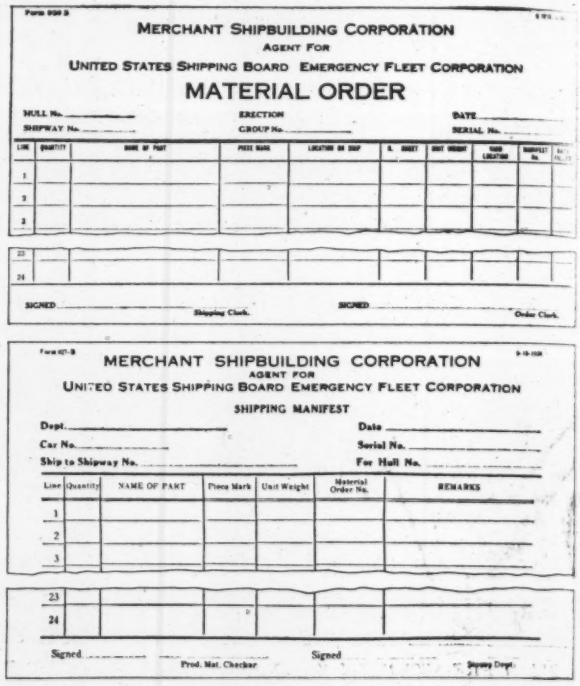


FIG. 6. SHIPWAYS SUPPLIED WITH MATERIAL ON WAY ORDER (UPPER FORM); STORAGE YARD SENDS MANIFEST (LOWER FORM) WITH EACH CAR OF MATERIAL SENT TO THE WAYS

composing the ship; these forms are filled out in advance in the main office of the production department, and, arranged in proper sequence, are turned over to the way clerk. They serve automatically as orders to the storage department, when dated, signed and issued by the clerk. Interleaved with these material-order sheets in the way clerk's file are placed Advance Notifications with respect to certain other work required in the construction of the hull, to provide for having such work

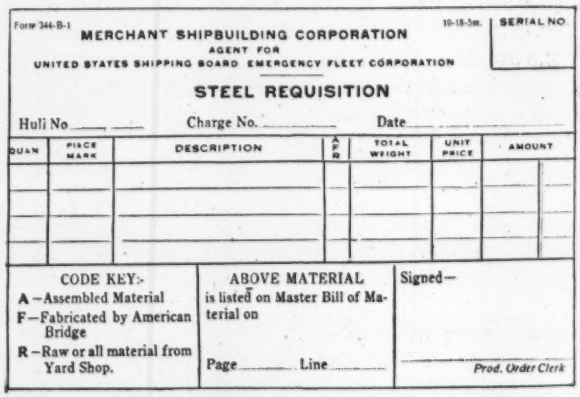


FIG. 7. STEEL REQUISITION CARD MADE OUT FROM MANIFEST FURNISHES BASIS FOR COMPLETE ERECTION RECORD

prepared for and carried out in proper timing for the needs of the ship erection. This applies, for example, to lifted shop material and to assembly work.

By use of the file of material orders the way clerk keeps a supply of material in the way storage, without special attention. He places his orders in accordance with general instructions to keep about three carloads on storage at the head of the ways. As there are 71

MASTER BILL OF MATERIAL FOR STEEL

DESCRIPTION PAGE

Line No.	No. of Pieces	PORT ST'B'D	PIECE MARK	NAME	LOCATION	Sections	DIMENSIONS	PAR. or RAW	Lb. or Tons	Weight in Lbs.	MATERIAL FOLLOW UP: Date Allot.	Ordered in: Date	Order	Delivered to Way: Date	Location	Req'n	Issued	Schedule Date to Weld	Adv. Sr. Dev.	Dwg. No.	Group	REMARKS
1																						
2																						
3																						

FIG. 8. FINAL BILL OF MATERIAL FOR COST DEPARTMENT MADE OUT FROM STEEL REQUISITION CARDS, TRANSFERRED AFTER ERECTION OF CORRESPONDING PIECES

erection groups in the entire hull, the average amount of material per group is about 40 tons, representing rather more than a day's consumption.

When the clerk issues an order to the storage department, the latter fills the order as detailed on the sheet (no partial shipments are allowed), and at the same time makes out a Manifest (see the form, Fig. 6). The material is delivered into custody of the boat foreman, who thereafter erects it as the requirements of his working force dictate. The manifest goes to the way clerk and is made the basis for the subsequent erection records.

Each piece entered on the manifest is transferred by the clerk to a Steel Requisition card, represented by Fig. 7. Horizontal numbering along the upper edge of this card, 1 to 31, guides the attachment of a tickler tab indicating the approximate date on which the piece should be erected. These steel requisition cards, placed in a file case, form the clerk's check on the erection operation, and are the basis for the final cost sheet. A card is taken out of this file when the foreman's daily erection report shows that the corresponding piece has been erected in the ship; it is dated with the date of erection, and the piece mark and weight are entered on a Master Bill of Material, Fig. 8, which, when complete, goes to the cost department.

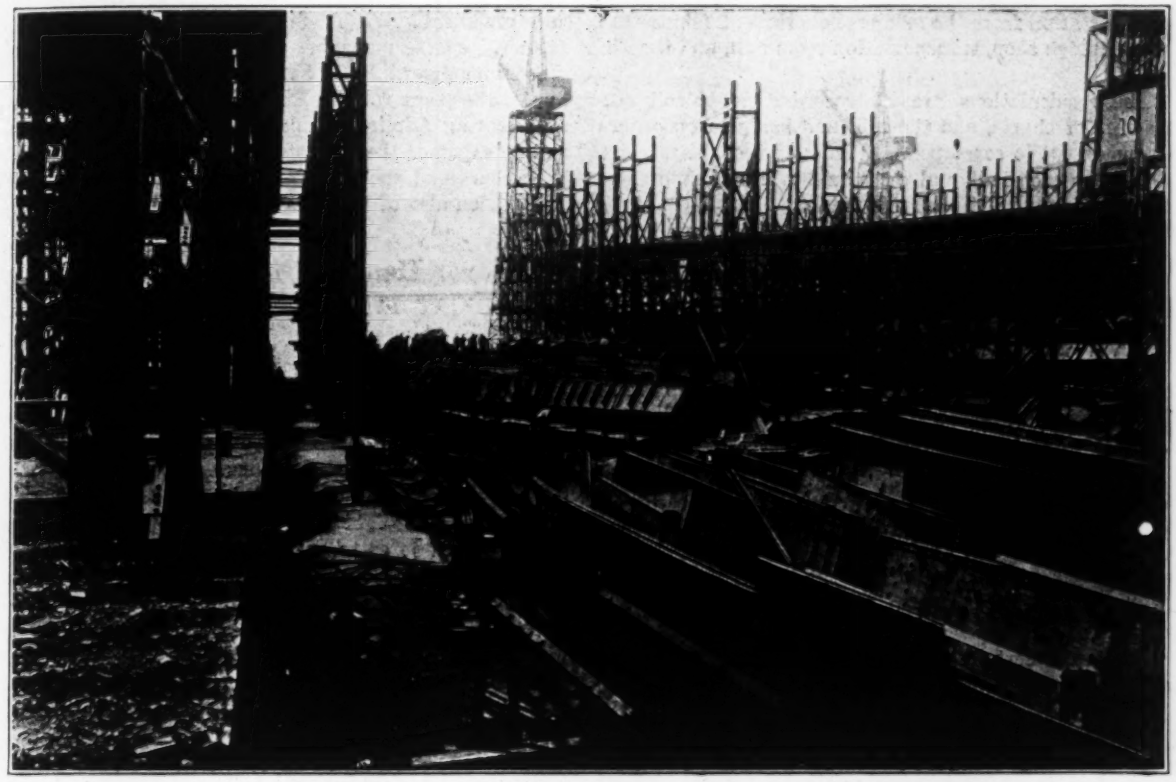


FIG. 9. SHIP ERECTION WORKED FROM WAY-HEAD STORAGE GIVING TWO OR THREE DAYS' SUPPLY

A check on the foreman's erection reports is had by noting when any steel requisition card remains in the file for some time after the estimated date of erection. The clerk can then take this card, locate the piece on the ship or in the way storage racks, and make corrections accordingly in his bill of material.

Advance notification, interleaved with the way orders as already described, are so placed as to allow about 10 days before date of erection for lifted material, and 18 days for assembly sections. The clerk sends these orders forward to the shop and assembly departments, each of which has an independent organization. The assembly department is organized in effect as a hull, with a foreman in charge. More elaborate organization is represented in the shop.

A clerk of the production department is located in the

shop, for handling the orders by which all work is initiated and routed. The shippers of the shop also are under control of the production department, and govern their reports and correspondence accordingly. Incoming orders arrive either from the way clerks (for lifted material) or from the dispatching office of the production department (for templeted material). In either event, the routing of the material through the shop is set forth on a standard form for the piece in question, on which are noted the successive operations required for its fabrication.

The ship erection schedule (Fig. 5) serves not only for control of the yard operations, but also for scheduling the bridge-shop orders. Basing the calculation on the time when a given piece will be required on the shipway, according to the erection schedule, successive allowances are made for storage (three days minimum), transportation from the bridge shop, time of fabrication in the bridge shop, transportation from mill, and time in mill.

These calculations are all recorded graphically on a series of charts, and the mill and bridge-shop orders are made out to correspond. Prints of these charts are allotted to each hull, and the actual mill and shop shipment and receipt times are marked in red on these charts, thus giving a graphical comparison with the scheduled or order time. One of the interesting results of an examination of these charts at Bristol is their showing the lag of mill and shop fabrication behind schedule time in spring and early summer of the current year, and the rapid improvement of these conditions, up to a marked lead over the schedule at present.

System Similar for Other Departments

All other departments of the yard—machinery, rigging, fitting-out, and the like—are controlled by systems which are similar to that described for the hull construction, and modified to suit the needs of the particular service. This is true not only of the installation of these parts in the ship, but also of the shop and store elements.

Orders for certain parts of the work of the equipment departments are interleaved with the hull construction orders, in the way clerk's order file. Thus, most of the ship tank piping is installed during the erection of the hull, and a certain amount of other equipment is put in. In addition, a distinctive practice of the Bristol yard is to install boilers and turbines in the hull before launching. This practice was followed for the first four ships built and will be continued, except in case of delay in the delivery of machinery. The parts in question can all be handled by the ship erection cranes, which, with an individual capacity of 15 tons, can handle 30-ton loads when two cranes are worked together. The added weight of the machinery is considered an advantage in launching, besides which a great amount of time is saved at the fitting-out dock.

A. H. Cooke, production manager, is in charge of the scheduling and routing work briefly sketched in the preceding. The principal officials of the company in active charge of shipbuilding operations are R. H. M. Robinson, president; W. T. Smith, vice-president; G. C. Thayer, general manager, and D. D. Smith, assistant general manager. H. E. Frick is authorized representative at the plant for the Emergency Fleet Corporation, representing Admiral Francis T. Bowles, assistant general manager of the Emergency Fleet Corporation, who is in charge of the fabricating yards and has general supervision also of the Delaware River district.

Conveyor Handles Freight at River Port

A FREIGHT-HANDLING conveyor for transferring freight between boats and cars at the Mississippi River port of Alton, Ill., is shown in the accompanying view. The carriage or frame travels on a track at right angles to the freight tracks, and carries a 45-ft. conveyor boom, which can be adjusted to the level of the deck or cargo hatch of the barge or steamer. At the head of this conveyor is a 20-ft. horizontal conveyor extending to the freight cars, and the farther end of this can be raised so as to load the car to its full capacity. A third 15-ft. section, not shown in the view, forms an extension for reaching cars on another track. When the carriage is run to the outer end of its track the boom can reach a barge or steamer outside the one moored to the dock.

Two classes of freight are handled by the conveyor, half of its width forming a continuous flat traveling apron or platform for boxes and other packages, while the other half has crossbars bent in concave form to receive barrels. The conveyors travel at a speed of 80 ft. per minute, and are all operated from a 15-hp. motor on the carriage. This conveyor was built by the Brown Portable Conveying Machine Co., Chicago. It is installed at the new waterfront dock and terminal, of the Illinois Terminal R.R., which was described in *Engineering News-Record* of March 7, 1918, p. 448.

FREIGHT CONVEYOR FOR TRANSFER BETWEEN BOATS AND CARS ON MISSISSIPPI RIVER AT ALTON, ILL.

Are American Engineers and Contractors Wanted in France?

Reports from French and Belgian Sources Show That Preference Will Be Given to Native Organizations and Men

AMERICAN engineers and contractors are asking to what extent they will be called upon to help reconstruct France and Belgium. Inquiries made by *Engineering News-Record* at all the official sources in the United States indicate that, although a large amount of American and foreign construction machinery will undoubtedly be used, participation on the ground by American engineers and contractors will probably not be encouraged by the two countries. The purchase of raw materials and semi-finished products, will, it appears, be confined as far as possible to home markets. Large-scale production of certain construction materials has already begun in Belgium.

Engineers on the staff of the French High Commission are unable to say what the reconstruction policy of France will be, because the recently organized Ministry of Reconstruction has not had time to forward plans. The impression prevails in both the New York and Washington offices of the commission that the ministry is awaiting some indication of the trend of the peace conference. The Washington office states that, although American engineers would be welcome in France as citizens of a country with which the warmest ties of friendship existed, French engineers, on account of their long service and great sacrifices in the war, will naturally receive preference. It is believed, however, that the supply of engineers will be ample, because of the comparatively short time during which it was necessary to use engineer regiments in front of the fighting lines.

Same Conditions in Belgium

The same conditions exist in Belgium. The Belgian information bureau in Washington states that the services of those engineers only who possess extraordinary ability or highly specialized talent will be needed, but both the French and Belgian officials say that there will probably be a call for engineers familiar with such American construction machinery as may be bought. But American engineers as well as machinery are desired by Belgium in the development of her African possessions.

The United States Bureau of Foreign and Domestic Commerce says that the question is largely one of credit. Purchases will be made in those countries holding the largest credits, and since it is probable that the United States will be the leading country in this respect it will also be the leading country supplying machinery and materials. As mentioned above, however, the local supply of raw materials in France and Belgium will probably be ample. Figures quoted by a German investigator in the Berliner *Tageblatt* recently, in discussing the Lorraine iron supply, give an index of the amount of iron available to France due to the recovery of that territory. The German writer stated that in 1913 the Lorraine and Luxemburg mines (the two industries being closely related) supplied 28,500,000 tons out of a total of 35,000,000 tons of iron ore used in the whole of Germany. He pointed out, however, that in the utilization of this large amount of raw material the French are handicapped by lack of furnaces and mills, they having been more concerned in selling the raw ores to foreign countries than in reducing it to the finished or semi-finished state themselves. He also stated that lack of available coke in France, (Germany having obtained it from her own sources) was another obstacle. These conditions, it is pointed out in Washington, will require a large amount of machinery and plant of a highly engineering character.

In commenting on the problem Richard L. Humphreys, chairman of the Construction Material Section of the War Industries Board, pointed out that before any extensive purchases could be made or work done a revision of credits would be necessary. The present war credits will cease to exist when peace is finally established. Measures will also be necessary to revive the purchasing power of the various European monetary units, Mr. Humphreys said.

Congo and Home Country

A student of Belgian home and colonial affairs, who resides in Washington, states that the finances of Belgium were in an anomalous condition in that although the home country is in financial difficulties, the colonies on the Congo have immense reserves of money and wealth. The Congo Free State was originally the personal property of the late King Leopold of Belgium, who, he explained, bequeathed it to the state at his death. The country, however, accepted the bequest in such a way that the revenue could not be used directly by the state, and although there are ample funds in the colonies they are not available for use in reconstruction work. The accumulation of this revenue, he stated, is very large, and the Government is working on a solution of the problem, through parliamentary or other action. It will therefore be some time before the work can be commenced on a nation-wide scale.

Other factors that will delay the final rehabilitation of the industrial life of Belgium are indicated in a recent United States commerce report. Industrial rehabilitation is vital, it states, yet the repair of the damaged ports, railways, highways and canals will be necessary before industrial reconstruction can be started. The railway equipment and rolling stock saved from the German invasion have been worn out from continuous military use on the French railways, and the network of canals will be out of use until it is repaired and the barges are replaced. The Belgian ports capable of accommodating seagoing vessels are not yet available for commerce, and the shipping itself has either been destroyed or diverted to other routes. Port equipment has been badly damaged or completely destroyed by the Germans, and the bridges and roads connecting the ports with the interior have been wrecked—so that even if sufficent shipping facilities were to be had the means for discharging and distributing cargoes is not available. The problem of the reconstruction of Belgium, the report points out, does not mean solely the furnishing of goods which she will need, but the complete rehabilitation of trade, industry and agriculture, as well as the actual rebuilding of devastated cities, towns and villages and rural regions.

It is also reported that extensive preparations for the further development of the Belgian Congo have been in progress for some time. A hydro-electric plant has already been erected, and the electrolytic reduction of copper commenced. The dumps of the copper workings that have been in existence for thousands of years are being worked over, and in the first four months of the plant's operation 40,000 tons of copper were shipped to England. It was found that the copper content in these dumps averages from 40 to 50 per cent.

Edmund Laplae, professor in the University of Louvain, and director general of the colonial ministry of Belgium, has been in the United States studying American methods and machinery. He has returned to Belgium to make his report, but will come back soon to engage American engineers and to purchase American machinery to be used in the development of the Congo colonies. It is also stated that he will not make any effort to interest capital. The development of the Congo had already been started before the end of the war, and as much equipment as could be gotten through the various embargoes has been sent over. A steamboat, similar to those used on the rivers of the Western United States, was needed for the upper Congo. M. Laplae found one in Pittsburgh ready to be shipped on a South American order, but held up on account of lack of cargo space. He bought it from the original consignees and managed to have it shipped to the Atlantic coast, where he obtained cargo space for it by an agreement with the Federal Government to ship a cargo of rubber in return. The steamboat is now in operation on the Congo.

Representatives of the Department of Commerce who have been studying the problem state that the people of France and Belgium hope and expect that preparations for the forwarding of needed supplies will begin promptly, especially since the invaded portions of the two countries have been reoccupied and it is possible to get definite particulars as to their requirements. The Belgian consul at New York states that information regarding his country may be had from the *Comptoir National pour la Réconstruction de la Belgique*, 15 Rue Louis le Grand, Paris, France, and that it has requested duplicate catalogues. Information regarding France may be had from the French High Commission, Washington, D. C., and catalogues should be sent in duplicate, in care of Lieut. Maurice Boyer, of the commission.

Four Methods of Sewage Treatment Studied at New Haven Testing Station

Miles Acid Process Advised for First of Four Permanent Works Rather Than Fine Screens, Imhoff Tanks (Each with Chlorination) or Activated Sludge—Results of Analysis, and Cost Estimates

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Professor of Public Health
Yale School of Medicine

AND

Dr. F. W. Mohlman
Chemist, Connecticut State
Department of Health

ELEVEN months' experiments at the sewage-experiment station established by the City of New Haven, Conn., have led to the conclusion that for the particular and somewhat unusual local conditions there prevailing the Miles acid process of sewage precipitation, with recovery of grease and fertilizer, is the best available method for one of the four plants necessary, and may prove advisable for the other three. The reason for the tests, the results obtained and the conclusions drawn are here presented, except that the Miles acid process is not taken up in detail because it was treated separately and at length in *Engineering News-Record* of Dec. 5, 1918, p. 1034.

New Haven has a population of approximately 160,000, and is sewered on the combined plan. The water consumption is very high, and the total sewage flow is estimated at about 35,000,000 gal. per day. Thirty million gallons are discharged from the main sewers of the city at five different points about the harbor. The present outfalls are all above low-water mark; the upper harbor is shallow (averaging less than 5 ft. in depth outside of the main channels), and the sewage as it spreads over the flats and deposits sludge upon them produces in many places a condition of gross nuisance. The pollution of bathing beaches and shellfish layings constitutes a very real danger to public health. The United States Bureau of Chemistry in 1915 forbade the shipment in interstate commerce of oysters taken from large areas in the harbor "unless such oysters were purified by transplanting them in nonpolluted water for at least seven days before shipment." In the following year the United States Public Health Service made an exhaustive study of harbor conditions. This resulted in the conclusions that the harbor was grossly polluted, that shellfish taken therefrom are filthy, dangerous and unfit to be eaten as taken from the area, and that bathing and swimming in the upper harbor are unsafe.

As a result of these conditions, an aldermanic and citizens' committee was organized in the spring of 1916 to study the problem. The committee consisted of Prof. C.- E. A. Winslow as chairman, Prof. S. E. Barney, A. B. Hill, H. B. Sargent and Aldermen J. W. Murphy and F. S. Nelson. It was assumed on the testimony of those most familiar with the local situation that it would not be economically advisable to attempt to intercept the sewage from the various outfalls and treat it at a single point, but that at least four different treatment plants must be contemplated, all discharging into the inner harbor. It appeared essential, however, to provide for outfall sewers to carry the sewage to submerged outlets in the main channels. The digestive capacity of the harbor waters is such as to render the production of a nitrified effluent unnecessary; but it was felt that a substantial removal of suspended solids and of sewage bacteria was demanded in order to avoid sludging up of channels or pollution of bathing beaches and shellfish layings.

To determine what methods of treatment were best

dapted to the solution of the local problem, as outlined above, an experiment station was operated for 11 months—June, 1917, to April, 1918. The total cost of the investigation was slightly less than $18,000. The immediate direction of the experiments was in the hands of the chairman of the committee, with Dr. F. W. Mohlman as chemist in charge and W. S. Sturges, Jr., as bacteriologist.

The experiment station was located at the outfall of the East St. sewer, which is not only the principal sewer of the city (flow of approximately 15,000,000 gal. a day), but also the most important one to study on account of its high content of industrial wastes. Special studies of certain processes were also made during the spring of 1918 at an outfall serving a residential district.

The processes studied were (1) fine screening; (2) Imhoff treatment; (3) activated-sludge treatment, and (4) Miles acid precipitation—all but the last followed by chlorine disinfection. The sewage for the experiments was obtained in a somewhat original manner, in order to avoid the breaking up of sludge solids by pumping. A considerable part of the flow in the sewer was diverted through a forebay from which the sewage needed for the experiments was withdrawn by means of a bucket elevator. This device proved highly successful and yielded an entirely normal fraction of the sewage flow suitable for accurate screening tests.

The sewage was distributed to the various devices over movable notch and rectangular weirs from a weir box in which the head was controlled by a Wallace & Tiernan regulator, operating a butterfly valve in the raw-sewage flume.

Peculiarities of the Raw Sewage

The sewage of the East St. sewer proved to be highly abnormal in several respects. It was very dilute, averaging for the 11 months 4.4 ppm. of ammonia nitrogen, 97 of total suspended solids, and 63 ppm. of volatile suspended solids. It contained during the first seven months of operation over 1000 ppm. of chlorine, which condition was traced to a million gallons a day of sea water used as condenser water in an industrial plant. Its bacterial condition was most peculiar. Samples collected on Sundays, Saturday afternoons and at 8 a. m. on certain week days gave normal results (1,470,000 bacteria and 143,200 colon bacilli per cubic centimeter); but samples collected during the industrial day showed only 160,200 bacteria and only 9600 colon bacilli per cubic centimeter. This condition we found to be due to the antiseptic action of copper salts derived from the washing of shells in a large munition factory Such a phenomenon appears not to have been previously recognized in the literature of sewage disposal, although recent studies by the Connecticut State Department of Health indicate that it is by no means unique, and that certain peculiar results noted in the Waterbury experiments in 1909 must have been due to the same factors. The effect of antiseptic wastes of this kind upon biological processes is of course a profoundly important one. The raw sewage showed an average "relative stability," or pseudo-stability, as we preferred to call it, of 58, when measured in the usual manner.

Screening studies were made with stationary screens 2 ft. wide by 3 ft. long, placed on cleats inclined downstream at an angle of 45° in a screen chamber 8 ft. 10 in. long by 2½ ft. wide and 2½ ft. deep. Two types of screen were tested, one of 30-mesh monel-metal wire cloth, and the other of galvanized-iron plates perforated with slots 1¼ in. long and $\frac{1}{16}$ in. wide. Sewage was in all cases passed through the screen under test at an initial rate of 100,000 gal. per day. As the screen clogged, the sewage gradually built up behind it, and in from 15 min. to one-half hour, when the loss of head had reached 2 ft., a second screen of the same type was placed in the chamber, resting on cleats 2 ft. below those on which the first was placed. After the second was in position, the first was pulled out of the chamber and allowed to drain. The second screen was kept in position until the loss of head had again reached 2 ft., when the sewage was bypassed, and the sewage remaining in the screen chamber was removed by the opening of vents in the side of the tank. After the sewage had been drawn down to within ½ in. of the bottom of the tank the second screen was removed and drained. The amount of sewage passed through the two screens in each experiment averaged about 3000 gallons.

TABLE I.—AVERAGE RESULTS OF SCREENING EXPERIMENTS

Sewer	Screen	Wet Screenings, Lb. per M.G.	Solids in Screenings, Lb. per M.G.	Solids, Per Cent. Volatile	Suspended Solids ppm			Settleable Solids, Per Cent. Reduction
					Influent	Effluent	Per Cent. Reduction	
East	Wire mesh	1,367	178	71	145	123	15	41
	Plate	665	86	82	137	126	8	29
Boulevard	Wire mesh	1,347	138	78	134	117	12	43
	Plate	386	28	82	135	132	3	29

After draining, the screenings were brushed off the screen and weighed, and the moisture content was determined. The effluent was sampled frequently during screening, and the suspended solids in the composite sample determined. Knowing the quantity of the sewage screened and the weight of the dry screenings, the parts per million of suspended solids removed and the per cent. of removal could be calculated.

Such studies of screening by the use of stationary screens is open to criticism on the ground that it permits a much greater clogging than would occur in practice with a revolving screen cleaned automatically during the process. The clogged screen will of course effect a greater purification than one that is kept clean. If the head were allowed to increase beyond a certain point, the pressure would operate in the opposite sense by forcing an undue proportion of solid matter through the meshes. With a loss of head never rising above 2 ft. this criticism cannot be made, since this is a range within which commercial screens are supposed to operate Our method of experimentation was therefore exceedingly favorable to fine screening, and working with an unusually fresh sewage we expected to obtain good results. As indicated in Table I, however, even the wire-mesh screens effected only 15% removal of suspended solids in the case of the East St. sewer, while the Boulevard domestic sewage (in which the solids were in a more finely divided state) gave an even lower degree of purification, the plate screens proving in each case inferior to those of wire mesh.

Altogether, it seems evident that fine screening, with

either wire screens (30 meshes to the inch) or plate screens (1¼ x ⅛-in. slots) cannot be expected to accomplish any important degree of purification with either of the sewages studied. Such screens will, of course, remove the grosser and more obvious floating solids and, where it is only necessary to avoid visual offense, they may be of great value. Where a substantial removal of suspended matter is desired, such as is accomplished by tank treatment, fine screens will not serve.

Our results are in accord with the general conclusions of conservative sanitary engineers. George W. Fuller, who is a firm believer in fine screening for situations to which it is adapted, estimates a removal of only 10% of suspended solids by such treatment. It is quite certain that a full-size installation of moving screens would accomplish less than the purification indicated by our tests. At Cleveland, several years ago, preliminary studies, made like our own with stationary hand-operated screens, gave a removal of 25 to 28%, while an actual Reinsch-Wurl installation (on another outfall sewer of the city) took out only 4% of the suspended solids present. Any such degree of purification as was indicated by our studies, or by the Cleveland experience, would, in our judgment, be inadequate for an effluent to be discharged into a shallow harbor with a narrow dredged channel, like that at New Haven.

Results of Imhoff Treatment

The Imhoff tank used in our experiments was constructed of tongue-and-groove spruce, with calked seams. It was 16 ft. long, 4½ ft. wide and 11½ ft. deep. The flow chamber extended for the full length of the tank, with gas vents 8 in. wide on each side. The flow chamber was constructed of heavy galvanized iron, with a triangular beam below the vent. The vent was 8 in. wide, and the seal overlapped each side 2 in. The sides of the flow chamber sloped at 60°, so that no difficulty was encountered from solid matters clinging to the slope. The capacity of the flow chamber was 840 gal. The detention period was theoretically 2 hours when treating 10,000 gal. of sewage per day. The linear velocity of the sewage was 0.15 ft. per minute.

The sludge compartment was out of proportion to the flow chamber, being relatively much larger than would be designed for a full-size plant. It was assumed that a large sludge compartment might be needed on account of the shallowness of the tank. The bottom of the tank was built in the form of two inverted pyramids with the sludge draw-off pipes just above the apices. When the tank was first filled with sewage it leaked badly. It was made tight only after many trials and was finally placed in service in November, 1917. It was unfortunate that operation should have been begun in winter, but by the end of April the increasing warmth of the season should have brought about normal conditions. Yet the results were at no period satisfactory, and they became worse as time went on. The average removal of total suspended solids for the six months' period was only 43 per cent., of volatile suspended solids only 38 per cent., and of settleable solids only 69 per cent. Sludge drawn from the tank at the close of the experiments was reddish-brown in color and highly offensive and dewatered badly, having in no respects the characteristics of a normal Imhoff sludge.

It seemed evident that with so weak a sewage as that studied sedimentation would not yield a very high degree of purification (this was confirmed by one month's study of plain sedimentation, which showed only 41% removal of total suspended solids) and that some factor, presumably the presence of the antiseptic industrial wastes, prevented the normal digestive action of the Imhoff tank. In view of the latter fact, it seems inadvisable to recommend this method of treatment for a disposal plant in a thickly settled district, on account of the danger that the operation of the tank and the removal of sludge therefrom, with a sewage of so abnormal a character, might be productive of local nuisances.

Activated-Sludge Treatment

Our activated-sludge experiments were made on the continuous-flow basis. The aërating tank was 16 ft. long, 4 ft. wide and 8 ft. deep. At the bottom of the tank the sides sloped at 45° to a trough 1 ft. wide, running the full length of the tank. An iron frame in which were cemented 15 filtros plates was cemented into this trough. The air was admitted at the inlet end of the trough, and the water which filtered through the plates could be drawn off at the outlet end. The air was compressed to 3.5 lb. pressure by a hydro-turbine having a capacity of 20 cu.ft. of free air per minute, the flow being measured by means of a venturi tube.

The settling tank was 4 x 4 ft. in plan, and 12 ft. deep to the bottom of the hopper. This hopper sloped at 60° to a sump in which was cemented a 3-in. ell connected to the suction of an air-lift pump. The sludge deposited here could be pumped back to the aërating tank, being measured on the way in an orifice box. A baffle 7½ ft. deep extended across the center of the settling tank. This baffle was first placed 3 ft. from the inlet weir and 1 ft. from the outlet weir, but the upward velocity of the effluent was too strong and carried particles of sludge over the outlet weir. After the baffle was placed in the center of the tank no sludge was lost in this way, the theoretical upward velocity being decreased by this change from 4.8 in. to 2.4 in. per per minute. The capacity of the aërating tank was 3100 gal., that of the settling tank 1150 gal. While treating 17,000 gal. of sewage per day with 50% returned sludge the aëration period was 3 hours, the settling period 66 minutes.

The activated-sludge process was studied less as an oxidizing than as a clarifying process, in the same way in which it was used at Cleveland. It was thought that activated-sludge treatment and chlorination might compete with Imhoff treatment and chlorination if the air and tank space required for the former process could be cut down considerably, and if the amount of chlorine required for disinfection were much less in the former case than in the latter. For this reason small amounts of air and short periods of aëration were used and no attempt was made to obtain full nitrification of the effluent.

The process was at first studied with an aëration

period of 2.5 hours, a mixture of 73 parts of very dilute sludge per 100 volumes of sewage, an air supply of 1.5 cu.ft. per gallon of sewage, and a sedimentation period of 55 min. All of these variables were modified at different times, the aëration period being varied between 2.5 and 10 hours, the proportion of sludge from 50 to 73 volumes per 100 volumes of sewage, the air supply from 1.1 to 2 cu.ft. per gallon of sewage, and the sedimentation period from 30 to 78 min. At no time and under no conditions could really satisfactory results be obtained. The sludge accumulated slowly, was rarely well flocculated and did not settle well. The effluents never showed a normal clarity. The removal of total suspended solids averaged only 55 per cent., and of settleable solids only 74 per cent. The nitrogen content of the sludge averaged only 3.23 per cent. The failure of the process no doubt was due in part to the design of the settling tank, the small size of the sludge pipes and the lack of a separate sludge-aërating tank; but we are satisfied that the primary reason for the poor results obtained was the presence in the sewage of the antiseptic industrial wastes which would render hazardous and uncertain the use with this sewage of any process depending on biological activities.

Experiments on Chlorination

The effluents from the screen chamber, the Imhoff tank and the activated-sludge process were conducted by wooden flumes to small baffled tanks, giving detention periods of 2 to 5 min. in which they were treated with liquid chlorine delivered from a special Wallace & Tiernan solution-feed apparatus. The samples of chlorinated effluent were held in the sample bottles for 30 min. before plating, to reproduce the action of the small storage tanks that would be required in an operating plant.

To interpret our results, it was necessary to fix on some tentative standard which might be considered adequate and satisfactory. For this purpose we have assumed as the ideal to be attained that the final disinfected effluent should contain not over 10,000 bacteria per cubic centimeter, and not over 1000 colon bacilli per cubic centimeter, as a general average. This represents a purification of over 99% for the normal sewage and about 90% for the day sewage at East St. containing the copper wastes. Activated-sludge effluent required 3 ppm. of chlorine to produce this result, and screened sewage, five parts, while Imhoff effluent showed average counts somewhat above the standard even after treatment with six parts, and crude sewage after treatment with 8 ppm. In making estimates as to the cost of chlorination of screen and Imhoff effluents, we have assumed that five parts of chlorine would produce a fairly satisfactory degree of purification, basing this assumption chiefly on the results of the colon test, which is of greater significance than the count of total bacteria. This amount might very probably have to be increased in practice, however, particularly in the case of the Imhoff effluent.

The process of precipitation with sulphurous acid, patented by George W. Miles, and reported on so favorably by Prof. R. S. Weston of the Massachusetts Institute of Technology (*American Journal of Public Health*, 1916, VI, p. 334) seemed deserving of special attention in our experiments, in view of the fact that such a process would not be interfered with by antiseptic wastes and would be favored by the low alkalinity of the East St. sewage, and also because it yields a clarified and disinfected effluent such as was desired in view of local conditions. [These tests were detailed at length in an abstract of a paper by Professor Winslow and Dr. Mohlman, printed in *Engineering News-Record* of Dec. 5, 1918, p. 1034.—Editor.]

Comparison of Various Processes Studied

The general average results of the various processes studied are indicated in summary form in Table II.

Of the various processes available for the treatment of city sewage, it is obvious that any form of filtration would be out of the question for a disposal plant located at the East St. outfall. Our studies have indicated that activated-sludge treatment cannot be considered, on account of the presence of industrial wastes which prevent the bacterial activities upon which this method of treatment depends. In order to secure the results desired, a substantial removal of suspended solids and a reasonably high degree of bacterial purification, there remain three possibilities: (1) Fine screening followed by chlorination; (2) Imhoff tank treatment followed by chlorination, and (3) the Miles acid process. It has been pointed out above that fine screening gave us a removal of suspended solids which we did not consider adequate for the protection of the harbor, and that the character of the sludge formed in the Imhoff tank was so abnormal as to threaten the possible production of a local nuisance. We have nevertheless given careful consideration to all three of these processes and have prepared for each of them preliminary cost estimates which are shown in Table III. (See next page.)

TABLE II.—COMPARATIVE RESULTS OF VARIOUS PROCESSES: GENERAL AVERAGES OF PER CENT. OF PURIFICATION

	Ammonia (N)	Turbidity	Solids — Total Suspended	Solids — Volatile Suspended	Solids — Settleable
Wire-mesh screens			15		41
Plain sedimentation	—30	23	41	34	86
Imhoff treatment	—12	14	43	38	69
Activated-sludge treatment	13	44	55	50	74
Miles acid treatment	0	36	61	54	90

The estimates are based on the production of SO_2 gas by burning sulphur (assumed to cost $36 a long ton) and on drying from 85 to 10% moisture (coal assumed at $7.50 per ton). We have estimated a very high cost for the construction of Imhoff tanks ($20,000 per 1,000,000 gal.) on account of peculiar local conditions of the outfall, since the tanks would have to be built for the most part below tide water. The cost of chlorination is based on the use of five parts of available chlorine per million parts of sewage, an amount which we have found essential for the treatment of either screened or clarified sewage. It is very probable that in actual practice more than five parts might be necessary.

It appears from these estimates that the acid treatment of the sewage from the East St. outlet should

be materially cheaper than either Imhoff treatment or fine screening, under existing local conditions. With a fall in the price of grease after the war the outlook would be less favorable. Even if all revenue from the sale of grease and fertilizer were eliminated, however, the cost would not be very much greater for acid than for Imhoff treatment. Other conditions make the case for the Miles process at this outfall almost irresistible. Our studies have shown that fine screens will remove only a small proportion of the suspended matter from either the East St. or the Boulevard sewers, and we are of the opinion that the purification so effected would not be adequate to prevent sludging in the dredged channel into which the effluent must be discharged. On the other hand, our experiments with Imhoff treatment of the East St. sewage have been most unpromising, as noted above, on account of the antiseptic action of the copper present in the sewage.

Above all, however, the thing that counts most heavily in favor of the Miles process under the conditions obtaining at New Haven is its freedom from nuisance. If heavy costs for interceptors and pumping are to be avoided, the sewage of the city must be disposed of at four different points, all of them in thickly settled areas where offensive odors must be prevented at all costs. Furthermore, the problem of disposal of sludge and screenings would present peculiar difficulties. A process of treatment which should be free from local nuisance and which wholly eliminates the problem of sludge disposal is ideal for such a local condition.

Normal Sewage at New Haven

Aside from a short series of screening tests and a month's operation of the Miles acid process on the Boulevard sewer, we have conducted no experimental work on the sewage discharged from the other main outfalls of the city. We know, however, from the United States Public Health Service survey and from analyses of sewage from the other outfalls made under the direction of Prof. S. E. Barney, that the sewers of New Haven, aside from that at East St., carry a fairly normal flow of domestic sewage. From the conditions of the case the processes likely to prove successful are limited to the same three combinations tested at East St.; and we know pretty well what fine screening and Imhoff treatment are likely to accomplish with an average American domestic sewage. Activated-sludge treatment could no doubt be applied successfully to such sewages as those in question, but the operation of four small units of this type would certainly be expensive, since the cost of power in New Haven is high and the sewage of the city is in general so weak that a relatively small revenue could be estimated from the recovery of nitrogen in the sludge.

To obtain an idea of the relative cost of the three processes which seem most suitable for local conditions, we prepared preliminary estimates for the treatment of the sewage of the Sea St. outfall, based on our studies of its principal tributary, the Boulevard sewer. These figures [$9.60 for Miles acid, $12.14 for Imhoff tanks and chlorination, and $12.35 per 1,000,000 gal. for fine screening and chlorination—Editor], which should be fairly typical for the other New Haven outfalls, show that the Miles process in this case is considerably more expensive than at East St.—first, because of the higher alkalinity of the sewage, and, second, because of the fact that the plant would be smaller (6,000,000 gal.) and costs per unit volume therefore larger. In particular, the cost of superintendence rises to a high figure, since we are convinced that a chemical industry

TABLE III.—ESTIMATED COST OF TREATMENT OF EAST STREET SEWAGE PER MILLION GALLONS

	Miles Acid Process	Imhoff Tanks and Chlorination	Fine Screens and Chlorination
Tanks and buildings (interest and depreciation)	$2 47	$5 28	$4 50
Acid treatment	6 93		
Drying sludge	2 09		
Degreasing sludge	1 78		
Redrying tankage	17		
Superintendence	1 06	46	46
Labor on tanks and screens	1 00	1 20	1 42
Disposal of sludge or screenings		1 00	50
Chlorination		4 05	4 05
Gross cost	15 50	11 99	11 03
Revenue	7 09		
Net cost	8 41	11 99	11 03

No allowance has been made in these estimates for royalties on the Miles acid process, which is a patented one. Before definite plans are made proper assurance should be obtained that such charges would be reasonable. In the case of Imhoff treatment, royalties in the past have been small as compared with the total cost of treatment.

of this nature cannot be carried out without expert guidance. Imhoff treatment is slightly dearer, for the same reason, in spite of lower construction costs.

The same objections which militate against screens at East St. limit the promising possibilities at the Sea St. sewer to Imhoff and acid treatment.

The gross cost of the Miles process is very high, and with a new procedure of this sort, never yet applied to purely domestic sewage on a practical scale, it must be recognized that many factors such as the difficulties in distillation and the deoxidation of diluting water caused by the contained chemicals, may cut heavily into the assumed revenue.

If the problem of the Sea St. sewer stood by itself, we should be somewhat in doubt whether to favor Imhoff or acid treatment, with the facts in mind. Since, however, the case for acid treatment seems so clear for the East St. sewer, we are of the opinion that it would be wise to delay construction at other New Haven outfalls until the acid process has been tried out on a practical scale at the point where it promises best results. If an acid treatment plant at East St. is successful, the drying and degreasing of the sludge from this and other plants could be conducted at one central location, the costs estimated for Sea St. would be materially reduced, and acid treatment might well prove economical for all the main outfalls of the city.

Lincoln Highway Maintenance in Pennsylvania

Pennsylvania has expended $747,505.78, during the past year in maintaining the Lincoln Highway, according to a statement prepared for the Lincoln Highway Association by J. Denny O'Neil, state highway commissioner. The main items of maintenance covered by this expenditure are: Surface treatment, 248 miles; reconstruction, 22½ miles; building of seven modern concrete bridges, and the necessary oiling. The report adds that this large sum was made necessary in great part by the thousands of United States Army trucks which used this highway during the year.

Aërial Cableways Successful in Northwest Shipyards

Similar to Loggers' Cableways—Ability To Get Men Expert In Handling Them Is One Secret of Success—Well-Planned Installations Are Fast and Flexible

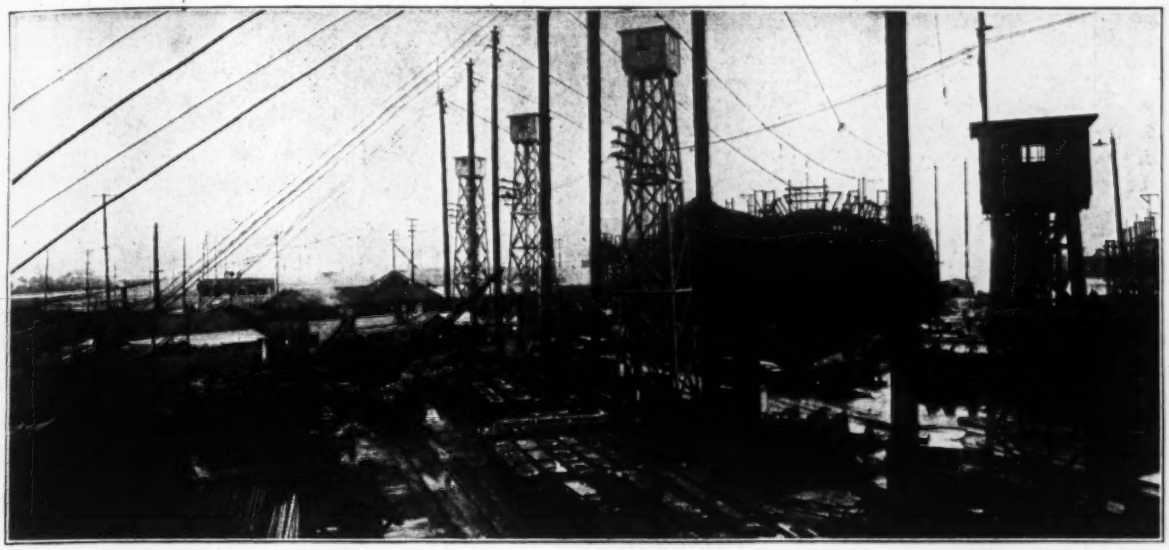


FIG. 1. THESE 125-FOOT TOWERS AT THE AMES YARD IN SEATTLE ARE FOR THE HOIST OPERATORS ONLY; THE WINCHES ARE ON THE GROUND

WORLD records in ship construction have been broken on the Pacific coast by yards handling materials with aërial cableways, a method which many shipbuilders do not regard with favor. Disfavor may be justified by the installations in some yards, but the good records of some of the well designed cableway systems and the high speed attained in placing steel speak for themselves. For example, the Skinner & Eddy yard at Seattle has recently launched fifteen 8800-ton boats in an average of 54.4 working days, and delivered them ready for service in an average total of 72.3 working days.

Moreover, the strong preference for cableways shown by managers of several successful steel shipyards indicates that the method will be for some time a factor in shipyard design. In fact, cableways are now being used in nine of the ten steel yards in the northern Pacific district of the Emergency Fleet Corporation. The first cost of an aërial cableway system is only a small fraction of the cost of overhead cranes, and the former can be built with materials quickly available on the Pacific Coast.

The aërial cableway idea was first applied in the Northwest early in 1915. When the Skinner & Eddy plant at Seattle was laid out in 1916 the system was installed on a comprehensive basis. Members of this firm had previously used cableways extensively in logging operations, and the methods employed in the woods were adapted to shipyard service. Expert riggers and operators were available from logging crews. Since that time the idea has been adopted by many of the new yards. Of course, the use of cableways presupposes the endwise delivery of material—that is, the cableway systems pick up material from storage inshore of the shipway and move it parallel to the keel. Thus, the system is best suited to yards in which the ways have to be built close together, and no storage alongside is available.

The layout and detail of design of the cableway systems vary greatly, but throughout the Northwest, in the more successful yards, there is a notable uniformity of main features. The most common arrangement is to have two cableways for each shipway, with bow and stern masts about 650 ft. apart. The bow and stern rows of masts are each tied together by cables at masthead, and are steadied by backstays and guys, as required. A three- or four-sheave tackle is usually put in the backstays to take up the slack in the main cables. The bow masts are usually set plumb, and the backstays are run out as far as anchorages can be conveniently placed. Where the ways front on deep water and it is inconvenient to use long guy lines astern, the stern masts are inclined outward, to increase the stability that may be obtained from short backstays and to keep the anchorages in shallow water.

It is the common practice to use counterweights on the dead end of the hoisting line and also on the carrier line, instead of making them fast to the masthead. This automatically prevents overloading the trolleys, and takes up slack in the carrier line. About one ton is used as the carrier-line counterweight; the hoisting-line counterweight equals the maximum load, usually about 2½ tons. The main cables are kept pulled up taut, with a sag not to exceed 3% or 4% of their length.

In one of the Northwest plants a temporary guy line was removed during construction before the permanent connection had been effected, and, as these ways were on an acute angle with the shore line, the entire row of bow masts fell over, doing considerable damage. In another plant the bow masts collapsed when one of the

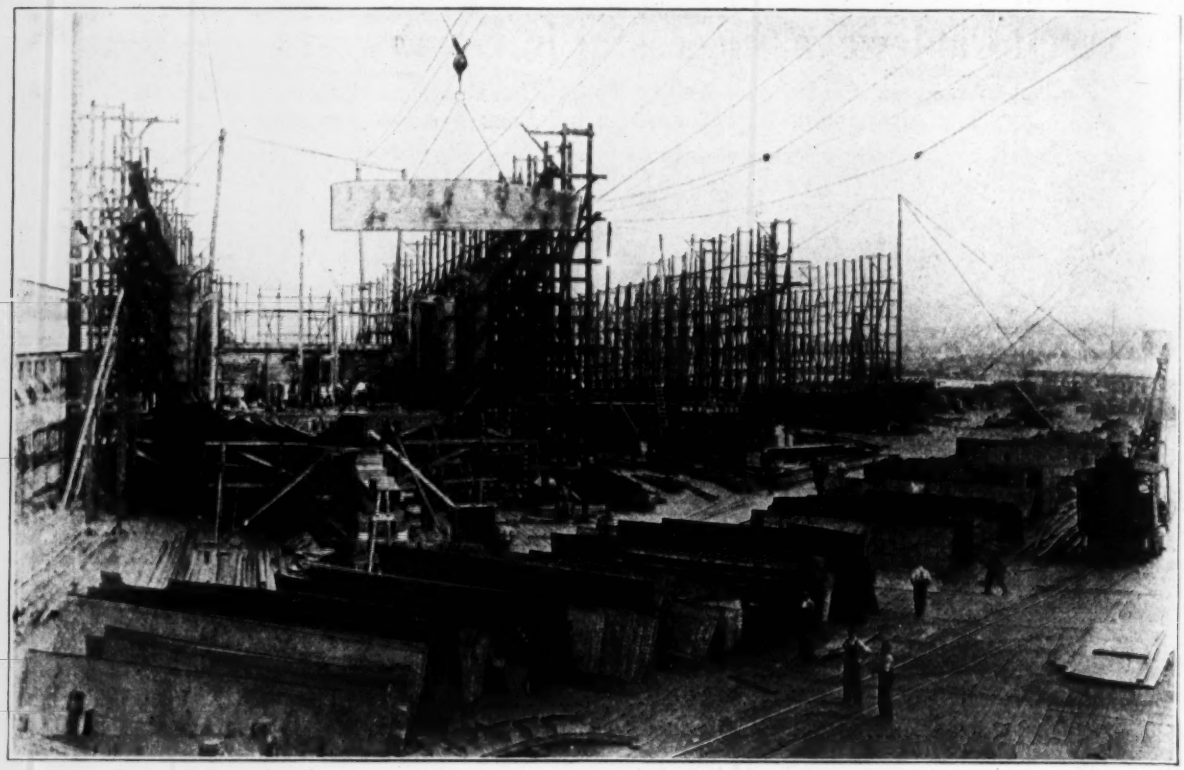


FIG. 2. TWO CABLEWAYS PER SHIPWAY USUALLY WORKED TOGETHER IN PLACING STEEL

main cables parted. This occurred, however, within a few weeks after the system had been installed, and is regarded as a failure to exercise sufficient care in design and inspection, rather than as a reflection on the cableway system.

The masts used vary from 105 to 125 ft. in height. The bow masts are usually 5 ft. higher than the stern masts, so loads are handled downgrade. The taller masts are conceded to have advantages over the 100- and 105-ft. masts which probably more than offset the additional cost. The 115-ft. masts are 3 to 4 ft. in diameter at the bottom and about 2½ ft. at the top. They cost at tidewater in Portland and Seattle between $300 and $400 apiece. Steel masts for this purpose have not been used in Pacific coast yards.

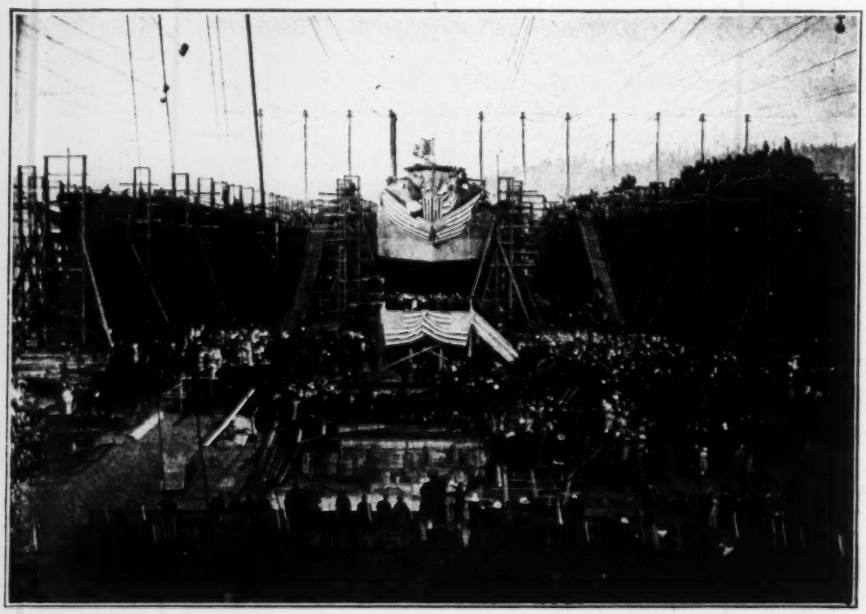


FIG. 3. CABLEWAY SYSTEM, SEEN FROM WINCHMAN'S HOUSE ON PLATE SHOP, TODD YARD, TACOMA

The main cables are almost all 1¾ in. in diameter. A notable exception to this is the system of the Northwest Steel Co. at Portland; this yard, which has been in operation for two years, uses a 1⅝-in. main cable of six strands, with hemp core. When one cableway in this plant had built three 8800-ton vessels, in each of which approximately 2800 tons of steel had been placed, the main cable was found to have been flattened somewhat on top. It was then replaced with a line of the same size having a steel core, thus increasing the strength without necessitating a change of trolleys. These stronger cables last for about six boats, after which the mechanical wear shown warrants their replacement. The ½-in. hauling cables average only three to four boats.

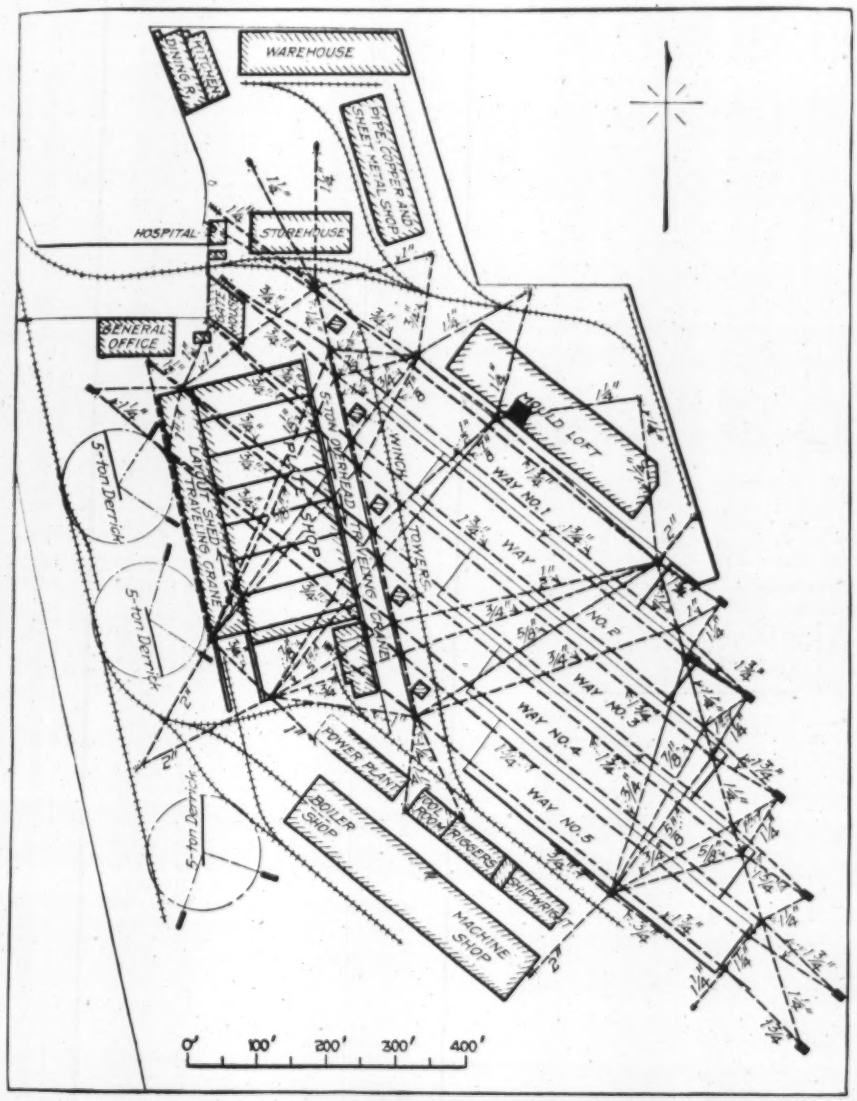


FIG. 4. PLAN OF SKEW CABLEWAY SYSTEM, SEATTLE-NORTH PACIFIC SHIPBUILDING COMPANY

Operating Control—An important operating feature of the cableway design is the location of the hoist controls. Most of the yards deem it essential for best results to have the operator where he has an unobstructed view of the work. Where there are no buildings located so that it would be convenient to set the hoist controls upon them, towers are built specially for this purpose. Most of the yards have the winches also in the towers; the cables run first to the ground and thence to and up the masts. At the Skinner & Eddy plant the winchmen are set on the ground. They are provided, however, with a telephone head-set with which they can hear a bell located well down the way, and which a signalman rings to indicate just how the load is to be moved.

Where a cableway is provided on either side of the way, towers are set on the center line, near the bow masts. Except for one steam-winch plant at Portland the hoists are all electrically operated, a separate motor and pair of drums being provided for each cableway. Where the two hoists for each way are mounted side by side, a single operator only is required. The two hoists in each tower are frequently so arranged that their traveling frictions can be locked together and the two trolleys operated at uniform speed, controlled by a single controller and brake. In this way one operator, handling both lines, can utilize the combined capacity of the two on a single lift or can separate them for independent operation.

Ordinarily, the two hooks are coupled together by a header cable about 14 ft. long, and the carriers are operated together for every load, to give the greatest precision in placing. It is generally reported by yard foremen that the two lines operating as one can deliver the material faster than it can be placed in the ship. The trolley speeds range up to 250 ft. per minute. In one of the Northwest plants the eight-hour operating record stands at 110 lifts with travel averaging 300 feet. The motors range up to 25 or 30 hp. and loads up to four or five tons can be handled by a pair of hooks combined.

Not all of the yards, however, use two cables per way. Some are using three and some four. In these cases one stern mast (on the way center line) has to be removed before each launching. A crew of six men does this in about half a day, without disturbing the other masts, thus leaving the two outer lines free to operate separately or jointly. Where four cables are used the central mast carries two cables separated by a spreader near the mast head. With the four-cable arrangement two winchmen are used in each tower, each man operating two carriers that can be coupled together or operated singly; all four hooks could be combined, but it is seldom done. Where three lines are used the two outer ones are usually worked together, the central cable being used for lighter loads. This three-cable system is commonly installed where oil tankers are to be built, because of the amount of material to go into the holds.

In the Ames yard at Seattle the towers are 125 ft. high and contain only winch controls, the winches themselves being set on the ground at the base of the masts. Under this plan the winches cannot be coupled together, and a separate operator is required for each carrier. Some of the shipways have three cableways each, and three operators are required in each tower constantly.

Although this is expensive in labor cost, it has the advantage of making the winches very accessible, and delays from breakdowns and maintenance costs are reduced.

In the Seattle North Pacific yard, the plan of which is shown, the ways had to be set at an acute angle to provide sufficient space for launching. This called for a more elaborate system of cross-guying than is usually provided, and required high masts so that the cross-cables could clear the main cables. The superintendent in this yard reports that the system is very easy to maintain, and riggers are always available when needed. The responsibility for the maintenance of the cableways is placed upon one man, who is expected to inspect personally all parts of the system as frequently as necessary.

The masts in this yard are particularly fine sticks, ranging up to 4½ ft. in diameter. They rest on a cluster of piles, on top of which a nest of timbers was built up for the foot of the mast. When the J. F. Duthie plant was built, masts of the desired height could not be obtained promptly for all the ways. Shorter and lighter masts were therefore used at the bow, and footings were built up above the planking 8 to 12 ft., as required to give them the desired height. These masts were strengthened by wrought-iron truss rods with turnbuckles for drawing them taut against struts placed at about mid-height.

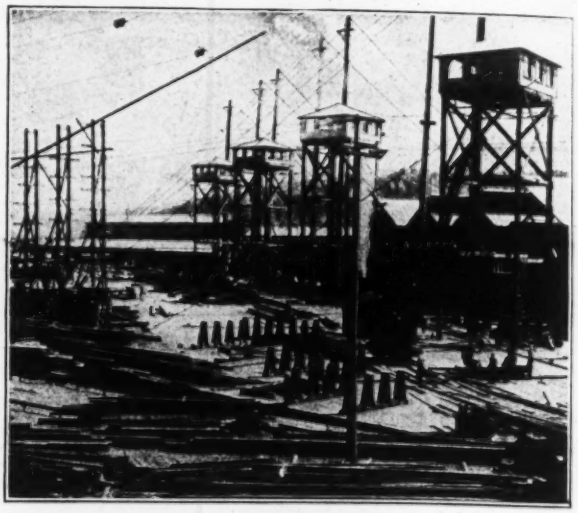
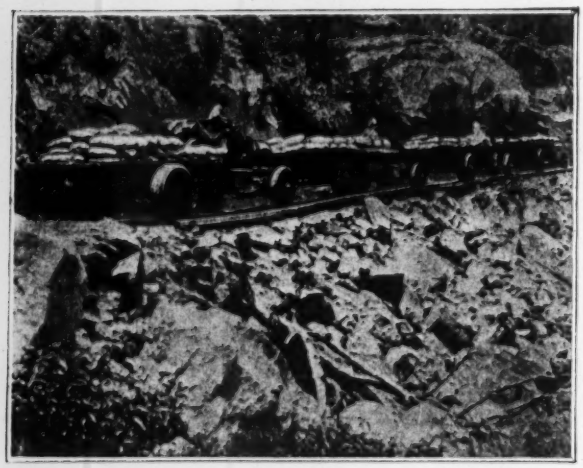


FIG. 5. CABLEWAY WINCHES IN CONTROL TOWERS, SEATTLE-NORTH PACIFIC SHIPBUILDING COMPANY

Motor Trucks Operate Over Steep Grades on Hetch Hetchy Project

TRANSPORTING of materials to the Eleanor Dam on the Hetch Hetchy project in California was an important factor in the construction problem. A fleet of motor trucks was used to haul materials over the first three miles. In this distance there are seven very sharp turns, which usually require a truck to reverse about three times in order to get around. Making these turns wider would have greatly increased the cost, because of the uniform slope of the hill along which the grade is located. Beyond this rise the grades and alignments are much better. The entire road was built in the three months between Apr. 20 and July 20, 1917, at a cost of about $6000 per mile.



HAULING CEMENT ON THE LONG 15 PER CENT GRADE

12 miles from the terminus of the Hetch Hetchy R.R., and was found to be entirely satisfactory, despite the rough trip involved. The costs worked out at about $10 per ton.

A 68-mile railroad built by the city terminates at the Hetch Hetchy dam site, and from this point a wagon road had to be built to the Lake Eleanor site. In order to get out of the valley, it was necessary to locate the road with continuous grades ranging up to 15% for

In the hauling contract the basis was a 70-sack load of cement, and the price was $35 per round trip of the truck. It was found, however, that by special agreement with the drivers each truck could make two trips a day. From a rough check on costs kept by the city it is estimated that the contractors' net profit has been about $5 per day per truck. There were eight trucks in the fleet and sixteen drivers. Most of the trucks were rated at 3½ or 4 tons capacity.

The work is being carried out by the City of San Francisco under the direction of M. M. O'Shaughnessy, city engineer.

Regulates Bottled-Water Traffic

Two hundred dollars fine is the penalty which Florida purveyors of bottled water must pay if they do not follow the stringent regulatory measures of the State Board of Health. First, there must be furnished to the board on Jan. 10 of each year the name of the water sold and the exact location from which it is obtained; chemical and bacterial analyses, or formulas, if the waters are manufactured. A permit must be obtained, and the board may revoke this if the water "appears to it to be a menace to health." Two bottled samples as prepared for sale are to be supplied to the board for laboratory examination every two months.

Engineering Educators' Opinions Reflect Past and Predict Future Conditions

Now that the Students' Army Training Corps has been disbanded and educators are actively engaged with the problems of the transition period of readjustment to peace conditions, the opportunity is being seized to initiate changes of far-reaching importance. In order to reflect these changes and present the trend of opinion among engineering educators, "Engineering News-Record" sent to the deans of various engineering colleges a communication containing the following questions:

1. What was the influence of the S. A. T. C. upon the engineering colleges? Did the experience affect the educator's viewpoint, and if so, how?

2. Will the return to peace mean a return to pre-war courses without essential modification? If not, just what changes are contemplated? What considerations determined these changes?

3. Have you embodied in your plans for after-war courses any of the suggested solutions brought out by Dr. Mann in his "Study of Engineering Education"? (See "Engineering News-Record" of Oct. 24, p. 782). If so, just how are they to be applied?

4. What is your estimate of the new needs and opportunities in engineering education developed as a result of the war? How can they best be met?

The replies which are here presented indicate the wide divergence of opinion which still persists through the war experience. It is hoped that practicing engineers will also coöperate in this vital matter of developing the best possible future for engineering education, and send us definite suggestions, in the nature of specifications for the desired graduates, in the light of war experience.—EDITOR.

Illinois To Make Readjustments, but No Permanent Changes Now

BY C. R. RICHARDS
Dean and Director of the College of Engineering, University of Illinois, Urbana, Ill.

IN REPLY to your letter asking my opinion concerning certain matters in connection with engineering education, I will undertake to answer your definite questions as follows:

1. If the war had continued for a year or two longer, it is possible that the organization of the S. A. T. C. would have had a decided influence on educational institutions. The signing of the armistice so soon after the organization of this corps has interrupted this educational experiment, to its detriment. It does not seem possible to estimate at this time the influence of this organization on the engineering colleges, although I have no doubt that in those institutions which undertook the instruction of mechanics and tenchniciams there will be an increased appreciation of the possibilities for intensive training of men for highly specialized work.

2. For the remainder of the current academic year, the College of Engineering of the University of Illinois has been compelled to make certain readjustments in existing curricula to permit the students to continue without being seriously penalized as a result of their experience with the S. A. T. C. Very little real work has been possible during the first quarter, and we have found it necessary to take this into account in outlining our program of studies for the remainder of the present academic year. At the present time, no permanent changes in the curricula are contemplated or are considered necessary or desirable. This college is alive to the need to keep in touch with changing conditions, but it does not feel justified as yet in making any revolutionary changes in its work.

3. During the past three months, as a result of the serious interruption to our work, the more or less complete disorganization of the university and a reduced staff of instructors, together with the extraordinary demands made upon the staff, we have had no time to give serious consideration to Dr. Mann's report. This report is to receive the careful consideration of the faculty during the year, and I have no doubt we shall make such use of the suggestions which Dr. Mann has made as may seem wise and practicable under existing conditions. I may frankly say that it would seem to me to be very unwise for any technical school to effect a complete revision of its curricula as a result of Dr. Mann's report, without giving the matter very careful thought and study.

4. In my opinion, there will be a greatly increased enrollment of students in the technical schools of America as a result of the war, for the importance to the nation of men with technical and scientific training has been demonstrated. It seems to me, therefore, that the industries should show an increased appreciation of properly trained men and of scientific research. Both in Europe and in America the need for research to enable the industries of these countries to meet new conditions which have arisen has been so strikingly shown that I anticipate that more attention will be given in the future to research in the colleges and in the indus-

tries. I have no doubt that there will be some disposition, as a result of the experience with vocational training in the Army, to assume that short courses of intensive training may be profitably substituted for the longer and more complete curricula of instruction given in the engineering schools. While I believe that vocational education should be stimulated in every possible way, I should consider that the substitution of such training for the broader training which the American colleges have developed would be little short of a calamity.

Rensselaer Polytechnic to Make no Radical Changes

By Palmer C. Ricketts
President, Rensselaer Polytechnic Institute, Troy, N. Y.

REPLYING to your four questions on the war education experience at Rensselaer Polytechnic Institute, I would give the following opinions:

1. The S. A. T. C. did not have a fair trial at this institution. The influenza affected the work seriously, and after the influenza came diphtheria. Many members of the Corps lost weeks of time. I hoped that the Government would be able to continue the corps in existence until June, in order that this form of military training at our educational institutions might have a fair trial. I hoped this in spite of the serious difficulties we had had, from an educational point of view, during the three months just ended. Since this experiment could not be tried in this way, I am at a loss what to say regarding military training in institutions of this character. Last year we had a paid instructor who gave military drill three hours a week to the students who elected to take it. We may have some such arrangement in the future. I do not expect that we shall establish a unit of the Reserve Officers' Training Corps here. What we want just now is a rest for some months before we decide this matter.

2. The return to peace will mean a return to pre-war courses without essential modification. We shall give five weeks' review here, beginning Jan. 2, and we shall give our second term as usual.

3. We have not embodied in our after-war courses any of the suggested solutions brought out by Dr. Mann.

4. We all know that the war has shown very forcibly the value of an engineering education to many persons who never before gave the matter much thought. Increased attendance at the engineering schools may result. It will be our business constantly to improve our engineering courses in the future, as they have been constantly improved from year to year in the past, but we certainly do not expect to make any radical changes in our methods.

General Effects on Middle West Universities Are Profound

By M. E. Cooley
Dean of the College of Engineering, University of Michigan, Ann Arbor, Mich.

HAVING been away from Ann Arbor since the middle of October, in charge of collegiate training of the S. A. T. C. at the universities of Illinois, Wisconsin and Michigan, I can only make a general statement in reply to your questionnaire. Engineering educators probably have the same opinion as other college teachers, the general verdict being that the S. A. T. C. was a failure, and that it is a pleasure to return to the old status. My own belief is that the S. A. T. C. was a pronounced success, considering it as a gigantic enterprise in operation less than 12 weeks and seriously handicapped by influenza. Another 60 days would have seen smooth sailing.

I further believe that educational institutions were stirred to their foundations, and will never return completely to the old status. Something was needed to jar them from their complacency, and the S. A. T. C. did it. Teachers have had an opportunity to adapt their courses to immediate practical needs, which should result in greater directness in the courses of the future. More important is the changed attitude of people toward the kinds of education desired. I hope and pray military training may be desired, for its discipline and leveling effect. What the country needs is escape from slavery to the almighty dollar, and education should strive to impart another ideal—such as responsible citizenship, for example.

Engineering education should be broadened and not narrowed; the biggest problems of the world today require men of vision, and the engineer of today is near-sighted. He can do one specific thing splendidly, and usually only one.

The above general statements answer your fourth question. In reply to the other three I would say: (1) The effect of experience with the S. A. T. C. is not yet crystallized, but the educators' viewpoint is undoubtedly changed; (2) yes, but not permanently; (3) no changes based upon Dr. Mann's report are yet proposed here.

Wisconsin to Return to Pre-War Courses

By F. E. Turneaure
Dean of the College of Mechanics and Engineering, University of Wisconsin, Madison, Wis.

REFERRING to your request for opinions regarding the effects of experience with the Students' Army Training Corps, I have the following to suggest:

1. The S. A. T. C. has, during the past quarter, interfered very seriously with the academic work of the College of Engineering at this institution, but it is generally conceded that the work of the engineering students has been better than that of the students of the College of Liberal Arts. This is probably due to the fact that the engineering students were pursuing studies more in accordance with the work they came to do than was the case with the other students. It is the judgment of the engineering faculty, I believe, that the lack of success of this experiment, from the academic point of view, was due partly to accidental circumstances and partly to the nature of the system itself—a combination of military and civilian life under two separate heads. The S. A. T. C. had a very considerable effect on the attendance, the number of freshman students being more than twice as large as the normal. Many of these will not return after Christmas.

2. With the demobilization of the S. A. T. C., the college will promptly return to its pre-war basis, without essential modification for the present year.

3. Due largely to the extra labor involved in the S. A. T. C. work, there has not been time for serious consideration of the suggestions contained in the report of Dr. Mann. This report will, however, receive careful consideration during the year.

4. I believe that the needs and opportunities which will be developed in the near future will not be radically different from those in the past, although they will doubtless differ considerably in degree. It seems apparent that engineering graduates have thoroughly made good in all kinds of war activities, and I do not anticipate any radical changes in engineering education. It is probable, however, that additional emphasis will be laid upon humanistic studies such as economics and sociology.

Missouri Sees Change in Spirit of Presentation of Courses

By E. J. McCaustland
Dean and Director of the School of Engineering, University of Missouri, Columbia, Mo.

ANSWERING your questionnaire in categorical detail, I would say:

1. On the whole, I believe the influence of the S. A. T. C. upon the engineering colleges was good. While a great deal of friction developed, due to an overlapping of authority, yet the results were, on the whole, helpful. The experience has affected the educators' viewpoint in regard to the possibility of holding the student up to a higher standard of accomplishment than has ordinarily been done in the colleges. This result, however, can only be accomplished through special effort on the part of the teacher, and I believe that all wideawake teachers of engineering have come to appreciate their opportunities more fully from having observed at first-hand the effects of insistent demands on youth even though such demands come from young and inexperienced military instructors.

2. Whether the return to peace will mean a return to pre-war courses without essential modifications, is a crucial problem facing the engineering schools. For ourselves, we feel that the change most desirable is a change in the spirit of presentation rather than in the substance of the courses offered. We must show the student wherein he is rendering a service to the community and to the state by his more earnest attention to his preparation. Since the main motive actuating the members of the S. A. T. C. was the consciousness of making preparation for definite service as officers in the Army, we must show them that preparation for professional fitness will be as great a service to the state in times of peace as the other preparation would be in time of war.

3. We have not yet fully discussed the possibility of embodying in our courses some of the suggested solutions brought out by Dr. Mann in his study of engineering education, but our men are examining this report very carefully, and I believe we shall feel the reaction from such study in the coming term's work.

4. Two points will be emphasized in future engineering education, as a result of the war. First, the arousing of more interest in and furnishing greater opportunity for research. In general, research is sadly neglected in the engineering schools or restricted to very high-class work. I believe that recent experiences indicate that we need to develop a wider interest in research, so that latent research ability may be brought to the front and receive an opportunity to develop. Second, more than ever before there has been impressed upon us the supreme value of a thorough training in the fundamentals of science and in covering a broad field, to serve as a basis for later specialization. I think both of these points can be met only gradually as the point of view of engineering educators begins to concentrate more and more on these needs.

Curriculum Changed at Tufts College

By Gardner C. Anthony
Dean of the College of Engineering, Tufts College, Mass.

IN THE engineering school of Tufts college a most interesting and somewhat radical departure from previous curricula will be made. It is in line with the suggestions made by the Joint Committee on Engineering Education (Dr. Mann's report). Some of the recommendations made by this committee are not entirely new to the Tufts Engineering School, and the new curriculum which is offered to the freshmen already entered, and those about to enter Jan. 2, 1919, will embody details which have been tested before, but never properly correlated.

During the past year intensive courses were tried out for freshmen, and it was observed that high-grade work and enthusiastic application to studies can be obtained by giving them courses of a laboratory character which shall serve as introductory to the special courses leading to the several degrees, and accompanying such courses by such mathematics and physics as may be necessary for the logical development of the subjects.

Very recently, too, a readjustment of the five courses in engineering has made it possible so to combine them as to reduce the number to three; namely (1) civil engineering; (2) mechanical and electrical engineering, and (3) chemical engineering. Furthermore, the faculty had already postponed some of the more advanced mathematics to the junior year and had proposed postponing some of the physics until a more appreciative period of student development.

On registering for the next term the freshmen engineers will choose an introductory course in one of the three engineering departments. This will require nearly one-half of the total time allotted for study. In addition to this major course, the student will pursue but two other studies, which in the second term will be English and mathematics, and in the third term English and graphics.

By this plan, the attention of the student will be confined to but three, or at the most four, subjects, which will be properly correlated and pursued intensively. One of these, the main introductory course, is designed to give a proper perspective of the relation of the professional courses to the theoretical studies.

In the second year, each of the three engineering departments will offer a second and more advanced course accompanied by the necessary mathematics, physics and other subjects, which latter will be taught as a part of the departmental course. But the student

must elect an introductory course in another department; thus, it is designed to require introductory courses in at least two engineering departments, insuring a broader type of education than can possibly be obtained by specializing in one department.

This plan will postpone the main course in physics until the junior year and the most advanced mathematics until the senior year. It will also admit of considerable more election in the junior and senior years than has previously been possible. The modern language course will be conducted with special reference to the study of the commercial relations between the United States and foreign countries. To this end prominence will be given to the study of Spanish.

[*Several have replied that they felt it was too early to make definite statements on the questions raised, as they are still considering changes and studying Dr. Mann's report. Other replies will be printed in a later issue.*—EDITOR.]

Beam Deflections Under Distributed or Concentrated Loading

New Algebraic Method Proposed for Cases Usually Solved by Graphical Calculation Gives Accurate Results

BY J. B. KOMMERS
Madison, Wisconsin

DEFLECTIONS of beams can be calculated by an algebraic method that compares favorably with the graphical method both in time required and in accuracy. It is intended for use in those cases of combinations of uniform and concentrated loads for which the ordinary algebraic method would become very long and tedious. Simple beams, cantilever beams, beams fixed at one end and supported at the other, and beams fixed at both ends, will be discussed.

Suppose a simple beam has upon it a concentrated load, P. When P is at the center of the span the maximum deflection occurs at the center; when P is at the right support the maximum deflection occurs $0.577L$ from the left support. This means that no matter where the concentrated load is placed on the beam its maximum deflection will always be very near the center of the span, and therefore that the midspan deflection will be practically equal to the maximum deflection. This latter fact is utilized as the basis of the new method.

DEFLECTIONS OF SIMPLE BEAMS

In Fig. 1 the maximum deflection due to the two concentrated loads is to be determined. According to Maxwell's theorem, the deflection produced at the center, O, by the load at A equals the deflection produced at A by the same load placed at O. Therefore, place the 7000-lb. load at O, calculate the deflection it produces at A; place the 8000-lb. load at O and calculate the deflection it produces at B. The sum of these two deflections will be the deflection that the two loads at A and B produce at O and, as shown above, a very good approximation to the maximum deflection.

The deflection which a central load P on a simple beam produces at a point distant x from the nearest support is,

$$\text{Defl.} = \frac{Px^3}{12EI} - \frac{PL^2x}{16EI} \qquad (1)$$

Applying this equation to the case of Fig. 1, in order to get the maximum deflection by the method outlined,

$$\text{Max. Defl.} = \frac{7000 \times 60^3}{12EI} - \frac{7000 \times 180^2 \times 60}{16EI} + \frac{8000 \times 36^3}{12EI} - \frac{8000 \times 180^2 \times 36}{16EI} = -0.1971 \text{ inches.}$$

As a check upon this method, the correct maximum deflection was calculated; it was found to be 0.1970 inches.

If the beam in Fig. 1 is loaded with 13,000 lb. at A and 2000 lb. at B, the approximate result is 0.50% too small.

If the beam carries distributed loads on parts of its length as well as concentrated loads, the method is applied by breaking the distributed load into several sections and replacing these by concentrated loads at their centers of gravity. In Fig. 2 is shown a uniformly loaded beam. Such a symmetrical case would not require special treatment, but is chosen here to illustrate the method. Consider the load divided into four parts; then calculation by the approximate method gives 0.2525 in., while the exact value of the deflection is 0.2462. Thus, the approximate result is 2.56% too large. The load can easily be broken up into six parts instead of four, and then the approximation will be only 1.21% too large, a precision comparing favorably with that of graphical work.

If the beam in Fig. 2 is loaded over the left half of the span with a uniform load of 21,000 lb., and this is then broken up into three sections, the approximate method gives a result which is only 0.44% too large.

DISTRIBUTED LOADS ON CANTILEVER BEAMS

In a cantilever beam any load will produce its maximum deflection at the free end, so that the method described involves no approximation for concentrated loads. Distributed loads are broken up into sections, as before, and replaced by concentrated loads. The deflection produced at the free end of a cantilever by a load at A, Fig. 3, is

$$\text{Defl.} = -\frac{Pb^2}{6EI}(3a + 2b) \qquad (2)$$

Applied to the numerical case shown in Fig. 4 it gives 1.438 in. (correct deflection 1.443), so that the approximate result in this case is 0.35% too small.

If the same beam is loaded with 7500 lb. uniformly distributed on the half next to the fixed end, and this load is considered broken up into two sections for applying the approximate method, the result is 5.2% too small. Greater accuracy may be obtained by breaking the load into a larger number of sections; if four sections are used the deflection at the free end is only 1.5% too small.

It should also be noted that when there are several loads on the beam the uniform load near the fixed end produces only a small part of the total deflection. In the case of a uniform load over the whole beam, the half next to the fixed end produces only 14.6% of the total deflection.

BEAMS FIXED AT ONE END

Fig. 5 shows the case of a beam fixed at one end and supported at the other. For the case shown the absolute maximum deflection occurs under the load when $a = 0.414L$. When $a = 0.95L$ the maximum deflection oc-

curs at a point $0.568L$ from the left support. When $a = 0.05L$ the maximum deflection occurs at a point $0.332L$ from the left support. It will be assumed that for all ordinary combinations of loading the maximum deflection will occur at $0.414L$.

In order to determine the maximum deflection, it is necessary to determine the reaction, R, at the support. To do this, treat all loads as though on a cantilever beam, and determine the deflection they would cause at the left end. The deflection due to R must be exactly equal to the deflection of the loads. Therefore, solve for R from the following formula:

$$\frac{RL^3}{3EI} = \text{Deflection due to the loads} \qquad (3)$$

The deflections due to the loads will be found, of course, by the approximate method for cantilever beams heretofore described.

When R is known, the downward deflection caused by the loads at $0.414L$ is calculated, and from it is subtracted the upward deflection caused by R at $0.414L$. The difference will be a good approximation of the correct maximum deflection.

The formulas to be used for calculating the deflection at A in Fig. 6 are as follows:

$$\left.\begin{matrix}\text{Due to}\\ \text{Load to}\\ \text{left of A}\end{matrix}\right\} \text{Defl.} = -\frac{P_1 b^2}{6EI}(3a + 2b) \qquad (4)$$

$$\left.\begin{matrix}\text{Due to}\\ \text{Load to}\\ \text{right of A}\end{matrix}\right\} \text{Defl.} = -\frac{P_2 d^2}{6EI}(3c + 2d) \qquad (5)$$

$$\left.\begin{matrix}\text{Do to}\\ \text{Reaction}\end{matrix}\right\} \text{Defl.} = \frac{0.1382RL^3}{EI} \qquad (6)$$

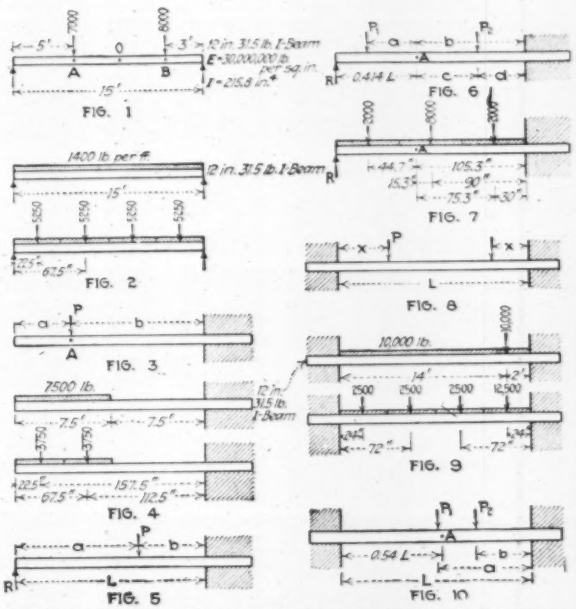
The method will be illustrated by working a problem which can be easily checked. Fig. 7 shows the loading. The deflection at the left end due to the loads is 1.2262 in. Then $R \times 180^3/3EI = 1.2262$, and $R = 4087$ lb. Using this value, the deflection at A due to R is found from formula (6) to be 0.5088. By formulas (4) and (6) the deflection at A due to the loads is computed as 0.5865 in. Subtracting, the net deflection at A is 0.0777 in. This result is 1.27% too small.

If the beam in Fig. 7 is loaded with a uniform load of 15,000 lb. on the left half of the span, and this is then broken up into three sections, the approximate result is 1.64% too large. If the same load is placed on the right half of the span the approximate result is 4.02% too small. Thus, for uniform load near the fixed end the degree of accuracy is not as great as for the same load near the left support.

Investigation shows that for the load near the left support increased accuracy can be had by breaking up the load into more than three sections. For the uniform load near the fixed end, however, the error is due to the fact that the maximum deflection occurs near the center of the beam instead of at $0.414L$ as assumed. It is recommended, therefore, that for those cases in which all the loads, both uniform and concentrated, lie to the right of the center of the beam, the deflections be calculated at $0.47L$ instead of $0.414L$. In this case the deflection at $0.47L$ due to the reaction is

$$\text{Defl.} = \frac{0.1155RL^3}{EI} \qquad (7)$$

If in the case of the beam loaded on the right half of the span the deflections are calculated at $0.47L$, the result is only 0.17% too small.



BEAMS UNDER DIFFERENT CONDITIONS OF SUPPORT AND LOADING ADAPTED TO ALGEBRAIC CALCULATION OF DEFLECTIONS

Fig. 8 shows a beam which is fixed at both ends. The absolute maximum deflection for a concentrated load will occur under the load at the center of the beam. Even if the load is distant from the right support only $0.05L$, the maximum deflection will occur at $0.653L$, or still quite near the center. This, of course, is an extreme case, and as in the case of simple beams it will be assumed that the maximum deflection occurs at the center. The deflection which a load P, in Fig. 8, causes at the center is given by the formula

$$\text{Defl.} = -\frac{PLx^2}{16EI} + \frac{Px^3}{12EI} \qquad (8)$$

The sum of the deflections found in this way will equal the maximum deflection.

Fig. 9 shows a numerical case with the concentrated load quite far to one side of the center. The approximate result in this case is 0.69% too small.

When the beam in Fig. 9 is loaded with a uniform load of 15,000 lb. over the right half of the span, and this is then broken up into three parts, the approximate method gives a result which is 2.85% too small. Investigation shows that the error is due to the fact that the maximum deflection falls to the right of the center instead of at the center, as assumed. It is recommended, therefore, that for those cases in which the loads, both uniform and concentrated, are all on the right side of the center of the beam, the deflections be calculated at a point $0.54L$ from the left end. For this purpose two formulas are necessary. The deflection at A, Fig. 10, is,

$$\left.\begin{matrix}\text{Due to}\\ \text{Load to}\\ \text{right of A}\end{matrix}\right\} \text{Defl.} = -\frac{0.06707}{EI}P_2 b^2 L + \frac{0.09332}{EI}P_2 b^3 \qquad (9)$$

$$\left.\begin{matrix}\text{Due to}\\ \text{Load to}\\ \text{left of A}\end{matrix}\right\} \text{Defl.} = -\frac{0.06707}{EI}P_1 a^2 L + \frac{0.09332}{EI}P_1 a^3 - \frac{P_1}{6EI}(a - 0.46L)^3 \qquad (10)$$

When the left half of the beam is loaded the distances a

and b in the formulas are measured from the left end of the beam.

When these formulas are applied to the beam shown in Fig. 9 with a uniform load of 15,000 lb. over the right half of the span, the result is only 0.17% too large.

The examples which have been worked show that the approximate method here suggested gives results which are at least as accurate as would be obtained by a graphical method. In the matter of speed in getting a solution, the method suggested will be found much superior in a great many problems.

Alaska Government Railway Nearly Half Completed

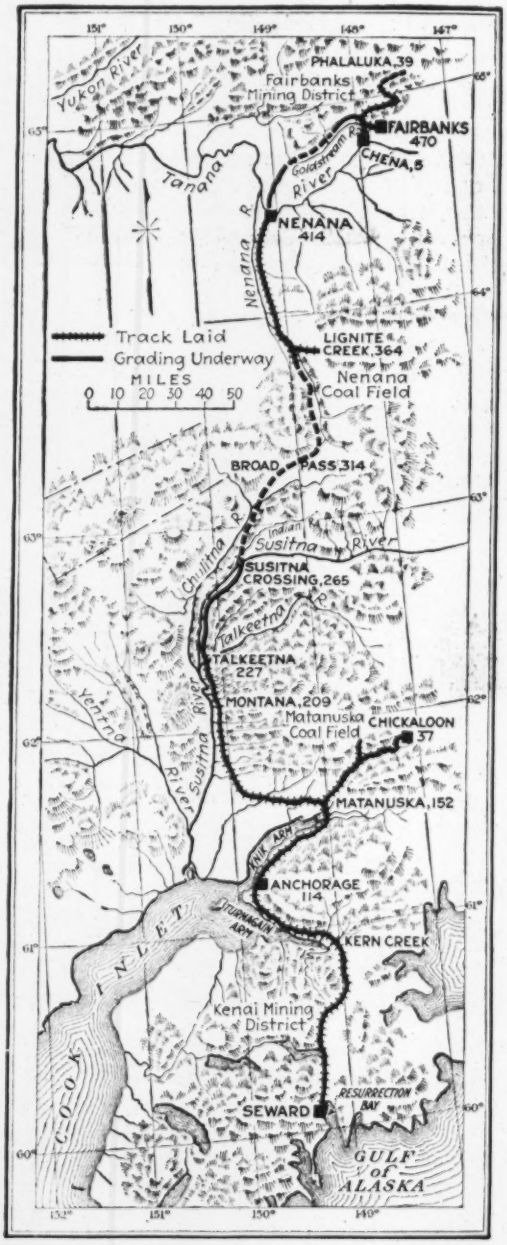
Main Line Open for 227 Miles, with 38-Mile Branch —Summit Elevation 2319 Feet—Grading By Stationmen

PROGRESS of construction on the Alaska railroad by the United States Government is called to attention by the recent completion of a 16-mile link which gives a 190-mile rail route from the Matanuska coal fields to tidewater at Seward, on the Gulf of Alaska. This was noted in *Engineering News-Record* of Sept. 26, p. 600. An extended article on the work up to 1916, by Thomas Riggs, Jr., formerly member of the Alaskan Engineering Commission and now Governor of Alaska, was published in *Engineering Record* of May 6, 1916, p. 600. The following brief review of this Government railway enterprise down to the present time is abstracted from a paper by Col. Frederick Mears, U. S. A., also formerly a member of the commission, in the *Alaska Railroad Record*. The route of the railway, with the parts completed and those under construction, is shown on the accompanying map.

An earlier commission, to study the transportation situation in Alaska, was appointed by the President in

GRADING ALONG SHORE OF TURNAGAIN ARM

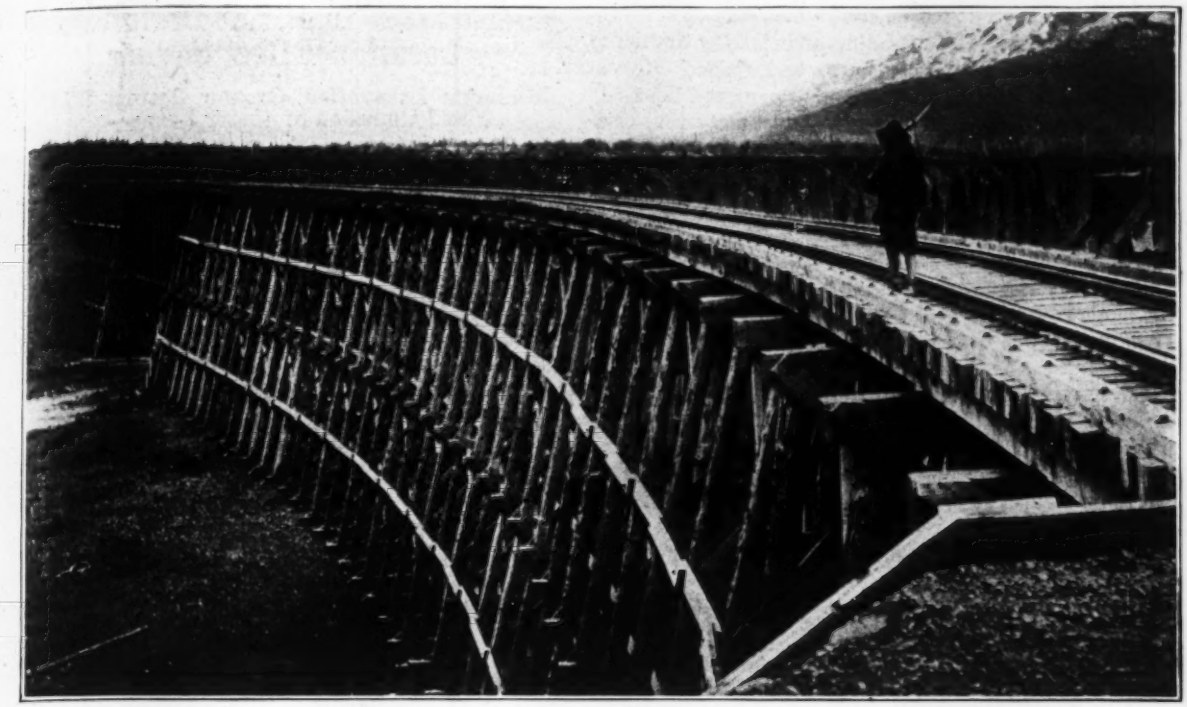
1913. This was headed by Maj. J. J. Morrow, Corps of Engineers, U. S. A., and its report was made in January, 1914. In March, 1914, Congress passed an act authorizing the President to construct and operate railways in Alaska and to acquire existing lines. The cost of the proposed system was estimated at $35,000,000.



MAP SHOWING TRACK LAID AND GRADING UNDER WAY

The present Alaskan Engineering Commission was appointed by President Wilson in the spring of 1914, with William C. Edes as chairman and chief engineer, to work under the general direction of the Secretary of the Interior. During the summer 13 parties were in the field, surveying mainly along two routes outlined by the first commission. Three bases of supplies were established: At Seward on the Gulf of Alaska (then the terminal of the Alaska Northern Ry.); at Anchorage, the head of ocean navigation in Cook Inlet, and at Fairbanks, the head of river navigation on the Tanana River. On the basis of the report made in 1915 the route from Seward to Fairbanks, 470 miles, was adopted, and in April the duties of the commission were extended to include the construction of the line.

The Alaska Northern Ry. was a private enterprise,



TRESTLE WITH TIMBER TRUSS SPAN ON THE ALASKA RAILROAD—EAGLE RIVER, MILE 127½

started in 1904 but abandoned in 1909 with track laid for about 70 miles from Seward to Kern Creek, of which about 47 miles were operated in summer by gasoline cars. This line was purchased by the United States Government for $1,150,000, and its rehabilitation cost about $1,800,000. The location of the new Government line, north from Kern Creek, follows along the shores of arms of the sea to Anchorage and then to the mouth of the Matanuska River, whence a 38-mile branch extends to Chickaloon in the coal district. It then strikes west to the Susitna River, which it follows to mile 265, where it makes a crossing and then follows the Indian River and the forks of the Chulitna River. After crossing the Chulitna Pass and Broad Pass the line follows along the west bank of the Nenana River to mile 373, where it crosses and follows the east bank to the town of Nenana, at the junction with the Tanana River. It then crosses the latter river and follows the Goldstream valley to the terminus at Fairbanks.

A summit elevation of 2319 ft. is reached in Broad Pass (mile 314) on the continental divide. The max-

STATION BUILDINGS AT ANCHORAGE AND STATION BUILDINGS AND COMMISSARY AT KING RIVER, MATANUSKA BRANCH

imum grades are 2%, but on the greater part of the line they do not exceed 1%. Grading and clearing are done in short sections by stationmen, and Colonel Mears states that in view of the abnormal war conditions of high labor and material costs it is fortunate that the commission adopted this system instead of letting a general contract under the very different conditions of 1915.

Grading was classified as solid rock, loose rock, frozen material and common excavation. Clearing of right-of-way was let at $35 to $100 per acre. Piles, culvert timber, ties and poles were obtained from native timber, but lumber was imported for bridge trusses and decks. Track-laying was done partly by steam tracklaying machines.

The heaviest construction on the entire line is along the north shore of Turnagain Arm. Occasionally there are short benches which were utilized for the roadbed, but for the greater part of the distance the roadbed had to be formed along steep slopes. The country is so rough that it was impossible to avoid heavy work even by the liberal introduction of curvature. In many cases heavy sidehill fills were made to avoid expensive cuts in the precipitous rock bluffs. The slopes of these fills extend into the water and are subject to erosion by the tides and waves. Timber culverts and trestles are numerous, with timber truss bridges over larger streams. It is estimated that about 8000 ft. of snow-sheds will be required in this district. These will have to be of substantial construction in order to resist the slides, which start from long distances up the cleared mountain side.

How Materials Were Distributed

For work north of Anchorage the camps were supplied largely by barges working along the east shore of Knik Arm. In order to expedite work on the Matanuska branch, materials were distributed for about 18 miles from the junction during a severe winter by bobsleds working on the bottom lands of Knik Arm and on the ice of the Matanuska River. Where the main line lies along the Susitna River for about 75 miles, materials and supplies were distributed along the first 50 miles by a stern-wheel river steamer of 100 tons cargo capacity, which had been used previously for construction work on the Grand Trunk Pacific Ry. On the next 25 miles the river is cut up into numerous channels, with intervening bars, so that navigation is difficult. For this part of the river three propeller boats of the tunnel type were used, having a draft of 12 in. when light and about 20 in. with a cargo of 30 tons.

In 1917 the Matanuska branch was completed, and in 1918 the tracklaying on the main line was pushed north to Talkeetna, the 16-mile link along Turnagain Arm also being completed. About 50 miles of track has been laid south from the Tanana River, and some work has been done around the northern terminal at Fairbanks, where the old lines of the Tanana Valley Ry. form branches to Chatanika and Chena.

William C. Edes is chairman and chief engineer of the Alaskan Engineering Commission. William Gerig is consulting engineer; F. D. Browne and R. J. Weir are engineers in charge; W. J. H. Fogelstrom is bridge engineer; F. A. Bailey and H. F. Dose are district engineers. The main offices are at Anchorage, Alaska.

Departures in Canal Design and Location Effect Saving

Minimum Excavation, Greater Bottom Width and Omission of Upper Levee—Full Tunnel Bore Used

By Everett N. Bryan
Chief Engineer, Waterford Irrigation District, Waterford, Cal.

Departures from customary practice in canal design and location have saved money for the Waterford Irrigation District, California. These departures have included changes in canal section, omission of the upper levee or bank, and grade changes in both canals and tunnels for the sake of economy. Canals have been satisfactorily located without using a transit. Mass diagrams have been used on excavation and embankment studies.

In one case the design of a canal of 100 sec.-ft. capacity which it had been proposed to construct with an 8-ft. bottom width, 1½ to 1 inner slopes and a 5-ft. water depth, had its bottom width increased 10 ft., its inner slope on the upper side changed to ¾ to 1, and the levee on the upper side entirely omitted. The prime reason for the change was that it was impractical to attempt to balance excavation and embankment quantities, because the materials to be excavated were largely talc, hardpan and soft sandstone, and wholly unfit for forming impervious levees. It was desirable instead to seek a design which would require the least depth of water above the natural ground surface with a minimum of excavation. The minimum depth of cut for the lower slope was fixed at 3½ ft. (except in the rare instances where the application of this minimum to the crossing of small washes would have introduced sharp and adverse curvature), and this minimum of 3½ ft. was increased to 4 ft. where outcroppings of hard material gave evidence of an unusually shallow earth covering and shortage of levee-forming material. Thus, in general, the maximum water depth above the natural ground surface was 18 in. and this was decreased to 12 in. or less when there was an exceptionally small amount of soil.

Greater Freedom for Scraper Movement

The advantages of the adopted design were found in greater freedom of movement for scraper teams in the bottom of the canal and a very considerable reduction in the quantity of excavation. An 8-ft. bottom width is a little narrow for easy operation of a four-horse scraper team in so deep a ditch in other than "cross-fire" work, and the alteration of the shape of the cross-section effected a reduction in the volume of excavation required, ranging from 6% for a 3½-ft. lower-slope cut on a ground-surface slope of 1 on 6, to 24% for a 4-ft. lower-slope cut on a ground-surface slope of 1 on 3½. The ground-surface slope for this particular canal varied between these limits on the sidehill location.

The omission of the levee on the upper side gave a considerable increase of materials for the levee on the lower side, where it was particularly important to strengthen that bank. There were few instances where the omission of the upper bank permitted the canal to spread out over more than a few feet. In addition,

the absence of an upper levee simplified to a great extent the problem of caring for drainage from above the canal. Had an upper levee been constructed, the number of passages through it or of culverts beneath the canal would have been very great and would have required a large expenditure. Without it, the drainage is collected by the canal and discharged at comparatively infrequent intervals through waste gates in the lower levee, where a minimum of damage will result.

Saving by Single Levee and Change of Location

The application of this plan of using a single levee was not abandoned in one extreme case where the water in the canal spread out to form a lake reaching back about 800 ft. and flooding several acres. At this point the original location followed the usual practice of a 3½ ft. minimum cut for the lower slope, and only a very small area was flooded. The location was changed when it was revealed by a new survey that by throwing a levee across the cañon at a lower point the length of the canal could be shortened 1700 ft., with attendant saving in grade and a 36% saving in construction cost over that of the original location, after paying for flooded ground and a levee of double strength.

The not uncommon practice of diminishing the section and increasing the grade was sometimes adopted for portions of canals lying in deep cut, but accomplishing much economy in this way requires a considerable sacrifice of grade, and this was not always practicable. In such cases another alternative was adopted—that of dropping the bottom grade and narrowing the section. This effected a considerable saving in excavation, with no loss in the water cross-section, and with the use of short, taper sections return could be made to the old grade at the lower end of the cut, without appreciable loss of head. A canal 4 ft. deep with an 18-ft. bottom width and ½ to 1 slopes may thus be narrowed to one of 13½-ft. bottom width and the same slopes, by dropping the grade only 1 ft. and creating a water depth of 5 ft. The water area will not be decreased, and the economy effected will vary from nothing for a 4-ft. level cutting to 10% for a level cutting of 20 ft. Still greater economy may be effected by a further lowering of the bottom grade.

The "jumping up" presents some difficulties to the lay mind, but it may be understood that it presents no real obstacles if one will but pause to study the bottom grade of any of nature's water courses. He will find there a grade which is not always continuous, but often adverse. Where the banks are obdurate, nature has a way of digging down for more room, and when again they offer less resistance than the bottom the grade of the bottom is "jumped up."

Saving Effected by Using Full Tunnel Bore

This method of economizing in the deeper sections of canal excavation is particularly applicable in the design and location of tunnel sections. Tunnels are often seen on irrigation, municipal and hydro-electric developments with the bottom grade located continuous with that of the canal above and below, and an area above the water surface almost equal to, if not greater than, the water area. In many of these cases it would have been practicable to lower the bottom grade so as to use the full area of the bore and thus save largely in the cost.

In one case, on a Waterford Irrigation District canal with a water depth of 5 ft., the bottom grade of the tunnel was dropped 3 ft. so as to fill the entire bore. The grade was not again "jumped up" until the lower end of the lower approach cut was reached. This was about 1300 ft. from the portal. The canal bottom in this approach cut was 8 ft. wide and the water depth was 8 ft., with side slopes of ¼ to 1. To have secured the same water area with an unbroken continuity of grade would have required a canal bottom width of 14⅞ ft. and ¼ to 1 slopes. The center cuts of this approach ranged from 28 to 8 ft. To have constructed this canal with an unbroken grade would have increased by 23%, excavation for the average cut in this portal.

Wasteway Provided to Cleanse Pocket

To cleanse the pocket created by the dropping thus of the bottom grade in the tunnel and lower approach, a wasteway was provided at the lower end. This continued the low grade to an open spill. Materials sloughed from the sides of the canal or tunnel may thus be sluiced out by occasionally diverting the discharge of the canal through the wasteway.

That the pockets so formed will fill to any great extent is unlikely. Débris or silt carried in suspension in a canal will not deposit unless the velocity of the stream is arrested, and this does not occur in such a case. Particles being rolled along the bottom may find difficulty in negotiating the grade at the point where the "jump up" is made, but in most cases this will cause little trouble. The increased water depth on the canal sides and the saturation of the top of the tunnel may induce a tendency to slough. Both this and the likelihood that pockets will fill must always be considered.

Where the materials taken from the canal prism were suitable for forming levees, an effort was made, of course, to balance the cut section with the fill section. On the side-hill location with a single levee it was found that the lower-slope cut would vary only a very little in securing this balance. It increased slightly as the inclination of the slope of the natural ground increased. The proper depth of cut at the lower slope could be easily determined for the various ground-surface slopes likely to be encountered, and because this depth of cut changed so little it was easy at any time to locate it on the hill side and know that a reasonably close balance of excavation and embankment areas was secured. The center cuts for the various inclinations of the ground surface were also computed, and it was these which were actually most used in the location work. They changed rapidly as the inclination of the ground surface changed, but with a little practice rodmen soon acquired the knack of calling for the proper cut. It was but a moment's work at any time to correct or verify the rodman's judgment by stopping to catch the lower slope.

Transit Not Used on Location

A transit was not used in location, and the work proceeded somewhat as follows: Without particular attention to alignment or chaining, the rodman proceeded from station to station, setting temporarily the

center stakes at an elevation on the side hill which would as nearly as practicable give proper balancing quantities—the levelman assisting by placing him where the cut would be that called for by the rodman. When in doubt, the rodman stopped to test his judgment by finding the cut at the lower slope. When the limit of the range of vision for the level "set-up" was reached, the rodman returned over the line to the initial point, ironing out the abrupt changes in the alignment. Beginning there again, he worked forward over the line, carefully chaining in and establishing the center line and taking cross-sections—the tapeman lining him in always to the next temporary center peg ahead. When the limit of the levelman's range of vision was again reached he moved forward. If a line of check levels be excepted, only once was it necessary to run an instrument over the line.

Now that construction of these canals is complete, it is doubtful that any difference could be detected between these canals and those located with the aid of a transit, unless the former should attract attention by reason of the evenness of their construction, because of the perfect balance between excavation and embankment. Nature has a marked tendency to work in easy curves, and as has been aptly said by an eminent engineer of the older school, "Water is not very particular just how it goes, so long as it can keep sliding down hill."

Mass Diagram for Each Canal

A mass diagram was worked out for each canal as soon as the yardage could be computed. It was the aim always to have this curve climb a little, and thus show an excess of excavation, to provide for the shrinkage which will almost inevitably occur in moving earth from excavation to embankment. If the curve was found to vary unnecessarily, the matter was considered by the chief, together with the locator. An estimate of the cost of relocation was easily made, and this was compared with the possible yardage to be saved thereby. A 100% perfect relocation would effect a 50% reduction in the excess cut or borrow, but in practice it is impossible of course to secure such a relocation, even were it desirable, and it is needless to say that in many cases the 100% perfect relocation, so far as lack of excess cut or borrow is concerned, is not the best location.

The locators soon developed a keen desire to develop the best mass curves practicable, because these were "yardsticks" by which their skill was readily measured. A miscalculation on the original location was an interesting field for speculation as to the percentage of perfection which could be obtained by another try. If it were known that the cost of a relocation, with attendant office expense, would be more than compensated for by a reduction in the cost of excavation, the relocation was made, regardless of the layman's censure of another survey or the additional charge to engineering expense.

The mass diagrams were placed at the disposal of contractors bidding upon the work and were interpreted to them if necessary. In the preparation of monthly and final estimates they were found invaluable. Duplicates were furnished to the foremen in charge of the grading crews. At first they had some difficulty in getting away from the idea that these were some sort of modified profile, but they generally did get away from such idea, and it was not long before many were ardent students of their mass curves and were cutting their haul effort to a minimum.

These were but a few of the economies practiced in the matter of the canal location and design. With such savings, together with those practiced in other branches of the construction program, success was achieved in putting through, without diminution in quantity or quality, during the years 1916, 1917 and 1918, the work intended to be done by bonds voted early in the first-named year. This was accomplished in spite of the phenomenal rise in prices which began late in 1916 and raised the cost of most construction by from 10 to 60% of the original estimate on which the bonds were voted.

Movable Towers Concrete Deck of Philadelphia Elevated

Station Work and Straight Sections on Six-Mile Stretch of Frankford Line Divided Between Two Mixing Gangs

HAVING one crew organized and trained for the straightaway concreting work between stations, and another with a separate organization for putting in the different type of deck required at stations, is the method adopted by the contractor in concreting the deck of the Frankford elevated line in Philadelphia. The stations have a track section with short ties embedded in concrete, which ballasted track is used between stations. Each of these gangs uses a mixing plant on the street, with a 40-ft. steel tower to hoist the concrete to runways on top of the structure. Each gang has two towers and two hoists, so that one can be moved and rigged while the other is being used.

PORTABLE TOWER PLANT

The Frankford elevated line, part of Philadelphia's new rapid transit system, was well under way when the war broke out, and now is so nearly completed that it is hoped it can be put in operation at an early date. The steelwork has been erected from Callowhill St. in Philadelphia to Deyer St. in Frankford, and about half of the 27,700 yd. of concrete to go in the track deck over this six-mile stretch has been placed. The steelwork consists of two types. One has columns on the sidewalks, capped by transverse plate girders which support three lines of longitudinal lattice truss girders, one between

the tracks and two outside. In the other type the three rows of lattice girders are carried on a line of single column bents between the car tracks in the center of the street. The problem of concreting the deck is the same on both types, the deck consisting of jack arches between cross beams at right angles to the track carried by the longitudinal lattice girders. As may be seen from the photographs, the concrete deck does not extend quite to the center of the outside girders, being carried only 12 ft. out on each side from the middle girder.

Sheet steel forms, curved to fit the arch section, and flanged along the bottom edges to rest on the lower flanges of the I-floor-beams were used. Each form section is 3 ft. wide and is collapsed by two turnbuckles. There are thus four of these forms to one arch on each side of the central girder, and with an average progress of 100 cu.yd. or a little more than 100 lin.ft. of structure per day for each gang, enough forms for about 1000 lin.ft. of double-track structure were provided. When the placing is being done close to the tower, and the buggy run is therefore short, as much as 160 lin.ft. is accomplished in a day by one gang.

Work on the deck was begun at the end of October, 1917, with a traveling mixing plant mounted on top of the structure. This plant, before it was closed down for the winter, concreted about ½ mile on Front St., where the base of the rail is 45 ft. or more above the street level on account of several railroad crossings. The plant consisted of a ½-yd. mixer supplied by overhead bins holding material for about 8 yd. of concrete. On the rear end of the traveler was mounted a small derrick, which supplied the bins, using a dump bucket. Three buckets were used, being loaded by hand on the street with sand and gravel. The derrick also hoisted the cement. The entire rig was mounted on one set of timber stringers and rolled on another. It occupied only the east half of the elevated structure, and, on account of the design of the steelwork, it was difficult to move it. The central girder of the steelwork was

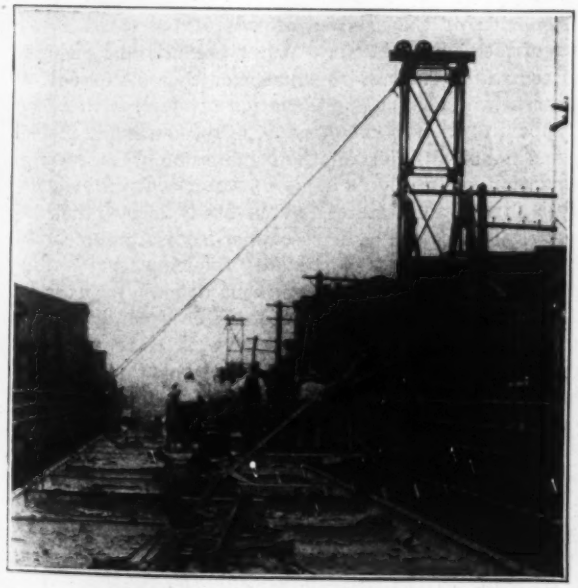
TRAVELING PLANT SUPPLIED BY DERRICK

at the same elevation as the outside girders, but sidewalk brackets carried on top of the outside girders prevented rolling the traveler on it. It was therefore necessary to use a platform of 12 x 12-in. timbers, extending from the center girder to the outside girder and resting on the latter between the sidewalk brackets to carry the stringers on which the traveler was rolled. These timbers were taken out and swung ahead by the derrick, which was placed so as to reach both ends of the traveler. It is stated that this plant proved to be slow, for its output was limited by the capacity of the one derrick.

When work was resumed last spring this traveler was dismantled and four steel towers were placed on the job. These were set up at street intersections and a length of one block each way was concreted from each set-up. While the concrete gang is using one plant, the rigging gang takes down the last tower and hoist and moves them ahead to the next set up. The towers are erected in sections, with a gin pole and crab. The plant investment is reduced by using only two ¾-yd. mixers.

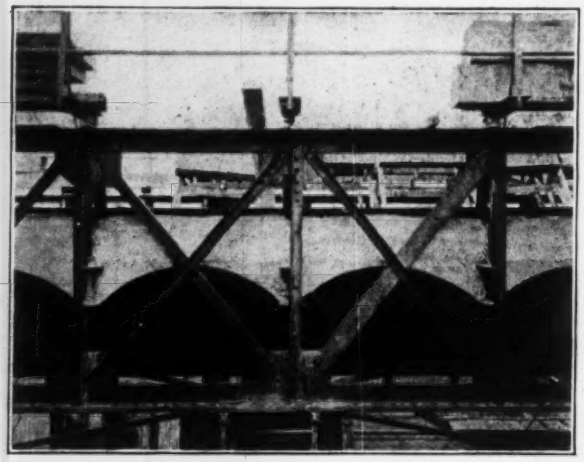
These are mounted on wheels and are pulled along the street by a truck. It is possible to move one of them and set it up while the gang is moving and reassembling the runways, buggies and forms. The mixers are of the type that is loaded by a charging hopper filled with wheelbarrows from material piles on the street. Sand, gravel, and cement are delivered in motor trucks by the material-supply firms, to the mixers.

The main runway is carried on the central lattice girder, the buggies being dumped down a movable chute into the section being poured. This runway is connected by a plank bridge about 12 ft. wide to the side of the structure at the tower, giving the buggies room to come up and turn under the hopper into which



CONCRETE PLACED BY BUGGIES FROM CENTRAL RUNWAY

the tower skip discharges. As the work progresses away from the tower, passing platforms long enough to hold about two buggies are put in at the side of



FORM COLLAPSED BY TURNBUCKLES

the main runway, being carried on joists to one of the outer girders.

The deck is divided into sections by the steel plate transverse girders which support the longitudinal girders, the spans varying from 42 ft. to 72 ft. It is usual to pour from two to three of these sections in a day, averaging about 100 yd. of concrete for each gang. The largest runs have been about 160 yd. The concrete gangs employ each from 38 to 40 laborers, four carpenters, three or four cement finishers, two to three foremen and two engineers. Each gang is under its own superintendent. While of about the same size, the gangs are organized differently.

The deck between stations is finished with a smooth top, on which a ballasted track is to be laid. The deck at stations is carried up to within 3 in. of the bottom of the ties, and paving stones are half embedded under each rail in the space between the ties, to form a bond between the deck and the concrete in which the ties will be set. When the station gang has finished all of these sections it will go to work on the curve sections, where the floor-beams spacing is irregular and special forms are required.

The erection of the steelwork was completed in 1917. The construction of the track floor, walk ways, and drainage provision was let to the Keystone State Construction Co., which sublet the concrete track floor to the Union Paving Co. The work is being carried on under the Department of City Transit of Philadelphia, of which W. F. Twining is director, and Henry H. Quimby is chief engineer. Construction is under the immediate supervision of M. Golder, division engineer.

New Law for Venezuela Railroad Concessions

A NEW law, states a commerce report, has been passed relating to railway concessions in Venezuela. New or changed provisions are as follows:

The Government will guarantee no interest on capital invested in the construction of railways.

A contractor for any railway must make a cash deposit proportionate to the length of the line and the width of gage—ranging from 600 bolivares per kilometer for 0.610-meter gage to 1400 bolivares per kilometer for 1.435-meter gage. The Federal executive may reduce this deposit at his discretion by as much as 15 per cent.

The Federal executive may or may not reserve in contracts the right of buying the railway and its equipment, with six months' notice to the enterprise. It is optional to the Government to make this purchase upon appraisal, paying 20% premium on the value of the enterprise, or by paying the price represented by value of the capital stock at the time of purchase with a premium of 10%. In all cases of purchase the appraisal shall be made by experts, and the purchase price shall be paid to the enterprise upon transfer of property.

The Federal executive shall have the power to require a reduction of rates when the annual tonnage transported by the road shall exceed a certain amount to be fixed in each case.

In contracts for building railway lines the following franchise shall be granted: Free duty on importation, during the first 25 years of the concession, of rolling stock, engines, tools, utensils and necessary implements for the building, exploitation and maintenance of the line and its branches, it being understood that said franchise shall lapse if it be proved that any of the exonerated goods have been designed to uses other than those of the company which obtained the contract, without express permission from the minister of public works. For the purposes of the exoneration of the custom duties the corresponding provisions of the code of finance must be complied with.

California Water Commission Advises Change

Abolition of the salaries of two of the three members of the California State Water Commission, making the remaining salaried commissioner the sole executive officer in water-right appropriation matters, with right of appeal to the full commission, is recommended in the second financial report of the commission. The recommendation is based on a study of water-control methods in 15 "irrigation" states, which study shows that in nearly all cases the plan recommended is in force. A vital need exists, the report states, for legislation giving an individual the right of eminent domain for rights-of-way for ditches, the same as is enjoyed by public utilities. This is necessary because it is required of anyone desiring to appropriate water that he have the right of access to the proposed point of diversion, and because of the frequency with which such rights have been withheld when an offer of reasonable compensation has been made. The commission began operations in December, 1914, and up to Sept. 1, 1918, had considered 1059 applications for water for agricultural, mining, power and domestic purposes. The commissioners are A. E. Chandler, Berkeley, president; W. A. Johnston, San Dimas, and Irving Martin, Stockton.

Training 350.000 Men for the Shipyards: How the Fleet Corporation Met the Problem

By J. Will Parry
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Building ships for the war emergency required many men, an army of skilled workers, to be assembled and trained in the shortest possible time. Ordinary methods of training were hopelessly inadequate for creating this force. The Emergency Fleet Corporation developed new methods by which it solved the problem. Personal training by working instructors made from intelligent yard mechanics is the core of the solution. Schooling for foremen and executives, to improve leadership, constitutes an important auxiliary development. Numerous other special fields of training called for the Emergency Fleet Corporation's labors. Mr. Parry, who was in close contact with the direction of the Education and Training Section of the corporation until his departure for Europe to take up educational work in the Army, sketches very briefly the methods used and some of the results attained.—Editor.

EARLY in the emergency shipbuilding the man-power problem was seen to be one of almost startling magnitude. There were about 40,000 shipyard workers in the country—not all of them in the shipyards. The full complement required to produce the ship output projected was about 400,000. Thus—disregarding that bothersome leak in the bottom of the pail, labor turnover—every shipbuilder had to be multiplied by 10, and that, too, at a time when all industries were bidding for skilled men.

Dilution processes, which depend on the survival of the fittest, could develop these men. But these are slow processes, and the men for the shipyards had to be developed rapidly. Furthermore, dilution would have involved, inevitably, a material loss in production, due to the skilled workers having to give time to instruction. Clearly, the task was hopelessly beyond the reach of dilution methods.

Three Sources of Labor

Labor could be obtained from three sources: First, skilled shipyard craftsmen not already employed could be impressed into the service (the supply from this source would be so soon exhausted as to make it a negligible factor in the problem); second, mechanics not trained in shipbuilding but skilled in crafts similar to the shipyard trades could be "converted" to the particular operations required in the shipyard. With men obtained in such ways might be considered partially trained mechanics in shipyards who could be developed to higher degrees of skill. Together, these groups could furnish a supply somewhat larger, but still hopelessly below the needs of the case. As the third and only remaining source, there was the supply of unskilled labor—green men with little or no knowledge of any mechanical trades. In view of the numbers required, this was the only source offering hope of meeting the needs of the case.

Thus, the kernel of the problem was, how to train absolutely green men and make them into shipyard workers, and do this rapidly enough to perform the work allotted to the yards.

Training men for shipyard occupations is not essentially different from industrial training of any other kind; and providing the men needed for quantity production of ships is essentially the same under emergency conditions of war time as under normal peace conditions. However, there was the magic bidding, "Do it quickly," and this, as a governing condition, did effectively stimulate decision, sweep away suspicion, and bring out into relief and place in proper grouping many facts and tendencies of training which under normal conditions of development come to light so slowly and in such scattered form that they are not easily distinguishable.

Nature of the Essential Training Task

When the shipbuilding program was planned, the shipyards of the country were forced to think in figures entirely beyond the customary in magnitude. Few of the managers could perceive all their problems clearly enough to be able to set them down in proper order and attack them consecutively. In consequence, plant construction got ahead of housing conditions, steel supply was now ahead of hull construction and now behind, and, in general, things moved by jerks rather than smoothly, as is inevitable with any great, unestimated project that is still finding itself. The man-power problem was one of the earliest and most obvious in claiming attention, and it remained the primary problem throughout the whole stage of shipyard development hardly concluded yet. The 61 shipyards, with 235 ways, of the early part of 1917, had grown to 198 yards, with 1083 ways, at the time the armistice was signed, and 80% of the ways were completed. This growth, and the numbers of men involved in both construction and in shipbuilding, will serve to define the problem of man-power, and hence that of training men.

The chief training problem was centered in the yards building steel ships. The seven concrete shipyards among the 198, for example, use, largely, unskilled labor. Wood shipbuilding, carried on in 114 yards, presents a much simpler labor development problem than steel shipbuilding. There is not so great a diversity of trades to deal with, and related trades of ready conversion possibilities are more numerous; also, dilution can be more readily accomplished, as the typical gang organization of the work is more nearly the

proper organization for training green men The 77 steel yards, therefore, presented the main bulk of the training problem. Again, in these, the hull construction trades constituted the most immediate need.

Ten trades called for trained workers in the largest numbers. These were: Bolters-up, chippers and calkers, drillers and reamers, erectors, rivet heaters, holders-on, riveters, shipfitters, ship carpenters, and electric welders.

Emergency Training Method Applied to the Main Problem

Two fundamental premises underlie the emergency plan of training developed by the Education and Training Section of the Emergency Fleet Corporation:

1. Learners must be instructed by work on production jobs, because: (a) Counterfeit jobs do not present a sufficient breadth of field for all-round effective training; (b) keeping learners off production work means waste of material and tools; (c) the stimulus of working on a job which will go to sea rather than on a play box is essential—as was recognized very early in the work.

2. Instructors handling gangs of learners must be men who are expert in the trade in which they are instructing, and who at the same time know how to teach it, and are free to produce skill rather than riveted plates. Training is essentially a production job, but its main product is skill, its byproduct is finished goods.

Production work, and working teachers, were thus the two essentials.

Any experienced training man will recognize at once that the critical element in this enterprise was the corps of instructors, the "skilled mechanics, who can teach." Teaching ability is sometimes called a gift. Emergency does not wait for gifts, however. It was necessary to develop the required number of yard instructors by training. The Emergency Fleet Corporation's training question, then, was to train yard instructors for training green men in yard crafts. The scheme developed for this work was to put selected mechanics through a training course designed to give them the necessary teaching ability. The success of the plan may be briefly indicated by saying that on Nov. 10 there were on the job 1100 yard instructors who measured up to their work about as well as do college professors or public-school teachers; and the training capacity of America's shipyards was somewhere around 15,000 men a month.

Mechanism of the Instructor Course—the Four Blocks

The mechanism of the instructor-training plan of the Emergency Fleet Corporation (shown by the diagram on the following page) is essentially this:

Selected mechanics of proved ability from various shipyards are sent to an instructor-training center for a six weeks' course. The class is under an instructor who knows teaching methods. His main function is to assist each man to classify his knowledge in such manner that he may be able to impart it effectively to others. The instructional material of the course is arranged according to a scheme developed by Charles R. Allen, superintendent of instructor training. Its characteristic is a division into four blocks, as will appear from the following outline.

Block 1—Job Analysis—Includes the analysis and arrangement of the occupational knowledge in an effective instructional order of jobs. The prospective instructor's knowledge of his trade is taken in the form and with the peculiarities as found; no attempt is made to impart trade knowledge or to teach standard practice.

Block 2—How to "Put It Over"—Telling what instruction is and how to accomplish it. The learner is made familiar with the successive steps in the instructing process, methods of approach and the like.

Block 3—Establishing an Effective Instructional Order—Teaching how to lay out operations in a difficult scale and establish checking levels for determining the progress of the learner.

Block 4—Instructional Management—Importance of good management for the emergency program; gang organization; meeting instructional conditions; getting along with production departments, and maintaining relationships.

Results of the Training Work Briefly Stated

Organized as suggested in the preceding, the training of instructors grew to remarkable proportions. The growth of training centers and of yard training departments has kept pace with the development of the shipyards and with their advance from the stage of plant construction to that of production.

On Apr. 15, 1918, three instructor-training centers were running; on Nov. 10 there were 36 centers. Thirty-eight shipyards had installed regular training departments, and 19 others had modifications of training departments. Training was proceeding in 42 trades and occupations.

The training capacity, based on the number of trained instructors, was not far from 15,000 men a month. Two yards were equipped to train 2000 green men per month each. Ten yards could train more than 500 green men a month.

What kind of instructors were being produced? The yard instructors went out from the training centers with the zeal of crusaders. They not only saw their trade or job in a new light, but they were fired with the consciousness of the power "to put it over"; and, not the least valuable characteristic, they had an entirely different—an almost impersonal—viewpoint as to the value and possibilities of the green man.

There had been an "instructor turnover." Instructors were lost through the yard gobbling them up for production foremen, for example. Training work has suffered from labor troubles, housing conditions, material supply slip-ups, and countless other difficulties. But so far no criticism has been made that the yard instructors could not "produce the goods."

An Experience: The Instructor's Faith—To a new yard instructor in a Great Lakes yard was assigned the job, as part of his practice teaching—before he got out from under the eye of the staff man—of instructing a green hand in laying off some angle clips. These had to be punch-marked and lettered with a brush, to conform to the mold. An especially green man had

PROGRESSION RECORD CHART

BLOCK NO. 1. The Analysis and Arrangement of Trade Knowledge in an Efficient Instructional Order of Jobs

Analysis	Trade Analysis	Classification	Blocks	Multi-Blocks

BLOCK NO. 2. How to Put It Over

1	2	3	4	5	6	7	8	9
The Instructing Process	Instructing Operation	Step One	Step Two	Step Three	Step Four	Lines of Approach	Technical vs. Production Lessons	Instructional Operation Sheets

Practice Lessons 1 Instructs 2 3 4 Yard 5 Groups

BLOCK NO. 3. Establishing an Effective Instructional Order

Instructional Difficulties	Difficulty Scale	Using Scale	Laying Out Instructional Order

BLOCK NO. 4. Instructional Management

1	2	3	4	5	6	7	8	9	10
War Situation	The Problem	The Plan	Instructional Management	Gang Organization for Effective Instruction	Instructional Conditions	Handling the Gang for Effective Instruction	Relation of Training to Production Departments	Instructional Bookkeeping	Sectional Problems of the Training Center

In Charge of a Group as Instructing Foreman on the Job

NAME..... .TRADE ..... INSTRUCTOR .....

been picked for this teaching practice. The learner completed the operations, but it was seen that he labored very hard over the lettering. On investigation it was found that he could neither read nor write.

Here was a difficulty which the old-time "breaker-in" would have given up in despair; not so the new instructor. Referring to the learner, he said, "But he's all right. He can *learn*. He showed it by the way he laid off the piece."

Instructor-Taught Men Efficient—In a certain North Atlantic yard the management was in a tight place with respect to riveting on a hull that was behind schedule. Ten riveting gangs still under instruction were pulled off the school work and put on the hull, along with 17 regular production gangs. The two sets of men worked side by side on the hull; there was no coddling or favored-job arrangement about it. The day's average for the new gangs was 278 rivets, that for the seasoned gangs 138. The highest drive of one of the new gangs was 318. The highest drive of one of the old-timer gangs was 240.

What the Professor Concluded—A former college professor who had deserted the field of economics to learn shipfitting passed through the "system," and, aided by native ability, advanced rapidly enough to become inspector on hulls. "I have never encountered a piece of teaching," said this specialist in instruction, "which took a fellow from where he was to where he was going by such direct and effective steps."

Improving Leadership the Second Great Problem

An army, no matter how efficient and well disciplined its troops, cannot be effective if it is not handled by capable officers. So, with the tremendous expansion of the shipyard working forces, the need developed automatically for more and better foremen, superintendents, quartermen, leaders and higher executives. This need was supplied in the time-honored way of picking a good mechanic, or a man with promise of leadership, and making him foreman. The results were as good as those in any industry using the same method of selection and bidding the new foreman "go to it"—and they were *no better*.

The foreman, using the term in its now common industrial application, makes or breaks the organization. Yet he is ordinarily left to his own salvation, to work out his own problems and plan his work. It was soon recognized that improvement in this part of shipyard operation was vitally necessary. The Emergency Fleet Corporation, therefore, organized classes in shop management and modern production methods.

These classes did *not* train men to become foremen; they trained foremen and executives already in the yard, to make them better foremen and better executives. No ready-made scheme or preconceived system could serve in this work. Each yard and its personnel were looked upon as a special problem, requiring its own individual treatment and solution, though of course the underlying principles of good management found application in each instance. As in the case of training the yard instructors, results were secured chiefly by guiding the individual through some of his own problems, and thereby imparting to him the ability to separate, analyze, lay out and schedule his own work in effective fashion.

Two very important and valuable byproducts developed: (1) A team spirit among the men, and a feeling that all were pulling together; (2) the successful solution in conference, sometimes in blood and tears but more commonly with gain of mutual respect, of certain "tough-nut" problems that had been in everybody's way.

Thus, in a New Jersey shipyard a certain group of men, all in the hull-construction department, and all from the same ways, had developed a tender spot over the use of the cranes. The men were more than merely touchy on the subject; they were completely at logger-

heads; each man cherished the idea that the other fellow was waiting just around the corner to "do him dirt." By devoting several hours to the matter, with the aid of the instructor as referee, carefully analyzing the problem, it was worked out to everybody's satisfaction, with the relief of much tension.

On Nov. 10 fifty-four foremanship classes were running. They were attended by more than 1800 men. One yard enrolled over 700 of its minor executives. In at least one case the coöperative spirit generated in these classes produced a most obvious result: By the action of the spirit of power and heave-together resulting from the foremanship conferences, a certain hull that had long been behind schedule and was daily slipping farther behind went into the water on the contract date.

Schooling the Trained Shipyard Worker

Manual instruction on the job gave little opportunity to provide the mechanics with that part of their equipment which may be described as the technical knowledge related to the trade. This knowledge is of vital importance in stimulating ambition, developing short-enlistment men into skilled and permanent employees, and creating in the individual a pride in his occupation. To aid in providing this knowledge, the Education and Training Section developed the Supplementary Training Branch. The work was done mostly through classes organized on the familiar plan of evening and part-time schools.

Over 8000 men in 38 yards have enrolled in such courses. The seven fundamental courses prepared and published for the work are: Elements of blueprint reading, blueprint reading for steel-ship construction, blueprint reading for wood-ship construction, elements of wood-ship construction, course for shipfitters, course for marine pipefitters, course for machinery erectors.

It is beyond question that such supplementary instruction succeeds in developing and holding craftsmen in all lines of industry. An extreme example comes to mind of the results that may be secured. The director of training of a certain Great Lakes yard organized evening classes. Among others there reported a man nearing 50, who had for 20 years been a common laborer in the yard. Instructors were skeptical of the chances of a man so old, and apparently so deep in a rut, ever climbing out. Nevertheless, he received a trial in the school. Today the man is a second-class shipfitter, and is still climbing.

Special Problems Handled by Specialized Methods

In many lines of war work it was found necessary to take craftsmen from various trades and make them into craftsmen for the specific war work in hand. In the shipyard field this "conversion training" was handled as a branch of the intensive training work.

Essentially, the method of handling it comprised analyzing the man's previous trade experience and, using this so far as possible, building up the training necessary for the new occupation.

Notable examples of such conversion were making ship riveters from structural steel riveters, ship carpenters from house carpenters, marine pipefitters from plumbers and steamfitters, coppersmiths from sheet metal workers, and outside machinists and machinery erectors from machinists. Careful and expert supervision and follow-up were essential in this instruction, chiefly in order to make sure that the men were getting just the type of jobs which would rapidly "convert" them.

Electric welding came up as a new problem. Its application to steel-ship construction, stimulated by the war program, has already passed through the experimental stage, and today it should be said, perhaps, that electric-welded ships are rather more than a possibility for the future. Here the Emergency Fleet Corporation found it important to work not only on the development of the art, but also on the training of men in this entirely new craft. To the latter task the plan of intensive training was also applied. About 100 craftsmen have been trained, in consequence, and some 200 are now in training.

Naval Architects Needed—In September the shipyards of the country made a call for 200 to 300 men of technical training in naval architecture and marine engineering. To meet this call, eleven-week courses were developed in two prominent universities. Only men of engineering training were admitted to these courses. As they already had the preparatory knowledge, as much naval architecture and marine engineering could be given to these men as is ordinarily given in a regular four-year course. Further demand for technical men by the shipyards will undoubtedly be met by the necessary response from universities and technical colleges.

That shipbuilding will live as the result of its revival under the stress of emergency—that it will adapt itself to peace conditions and remain an essential part of American industrial life—must today be regarded as assured. The need for trained shipyard workers therefore will continue. The national emergency has also brought out specialization in higher degree than known before. The trend will be toward the development of trades largely new to the American people. Whatever the course of coming development may be, however, shipbuilding will have the advantage of a more ample fund of training experience than any other industry in the country. This training constitutes a secure foundation for the future.

Omaha Public Works To Cost $2,000,000

An extensive program planned by the Department of Public Improvements of Omaha, Neb., will involve the expenditure of about $2,000,000 for sewers, paving and grading, and the extension of the park and boulevard system. The paving projects include the improvement of the main arteries leading into the city and the principal connecting streets, which will cost approximately $500,000. For parkway and boulevard development there will be acquired about 160 acres of wooded ravines, sparsely covered with dilapidated dwellings. The sewer work includes the construction of a trunk line system outside the city limits, and a disposal plant to serve the Saddle Creek drainage area. The planning and execution of these improvements are under the direction of John A. Bruce, city engineer.

Fabricating Shop and Berth Equipment at Sun Shipyard

Assembly Bay of Shop Delivers Finished Material to Shipbuilding Cranes—Multiple Punches and Roller Tables—Reinforced-Concrete Berths Served by Bridge Cranes

A FABRICATING shop specially planned along original lines for systematic working and direct routing of hull steel to the berths forms the central feature of the Sun Shipbuilding Co.'s new plant at Chester, Penn. The yard was designed 2½ years ago for building large oil tankers and cargo steamers; since December, 1916, when it began operation, it has put into the water 12 hulls of 10,000 to 13,000 tons, two of them said to be the largest freight steamers ever built. Among the features that give character to the yard, besides the shop, are concrete pile-bent shipways, bridge cranes on high runways serving the berths, a fixed hammer-head crane serving the wet dock, an excellently equipped boiler shop of capacity exceeding the needs of the yard, and a large engine and machine shop nearby—the plant formerly owned by Robert Wetherill & Co., Incorporated.

The enlargement and rearrangement of the fabricating shop are now being carried out to improve the balance of its departments. It is believed that when this work is completed the shop will rank second to none in the country for completeness of equipment.

In order to carry the idea of direct routing through from the raw-steel storage to the berths, the shipbuilding end of the Sun yard is arranged as a compact group. There are five shipways, and the shop stands immediately at the head of the ways, with a space of only 150 ft. between its delivery side and the bow of a ship on the stocks. The crane runways over the berths are extended to the shop wall, and the cranes take their material directly from the doorways of the shop, where the bridge cranes in the building deposit it.

Separate Layout and Assembly Bays.—As originally planned, the shop consisted of three sections forming one continuous building. The main section in the middle, 225 x 300 ft., is the fabricating shop, with its shorter side facing the shipways. Across the incoming end of this portion is a layout bay 80 x 500 ft., with a mold loft over it. In similar position across the outgoing end is an assembly bay 80 x 600 ft., so that the entire shop has an H-shaped layout. Some of the specially interesting structural features of the framing of the building were described in *Engineering Record* of Oct. 21 and Dec. 16, 1916, pp. 498 and 734. The layout and assembly bays are served by two bridge cranes each,

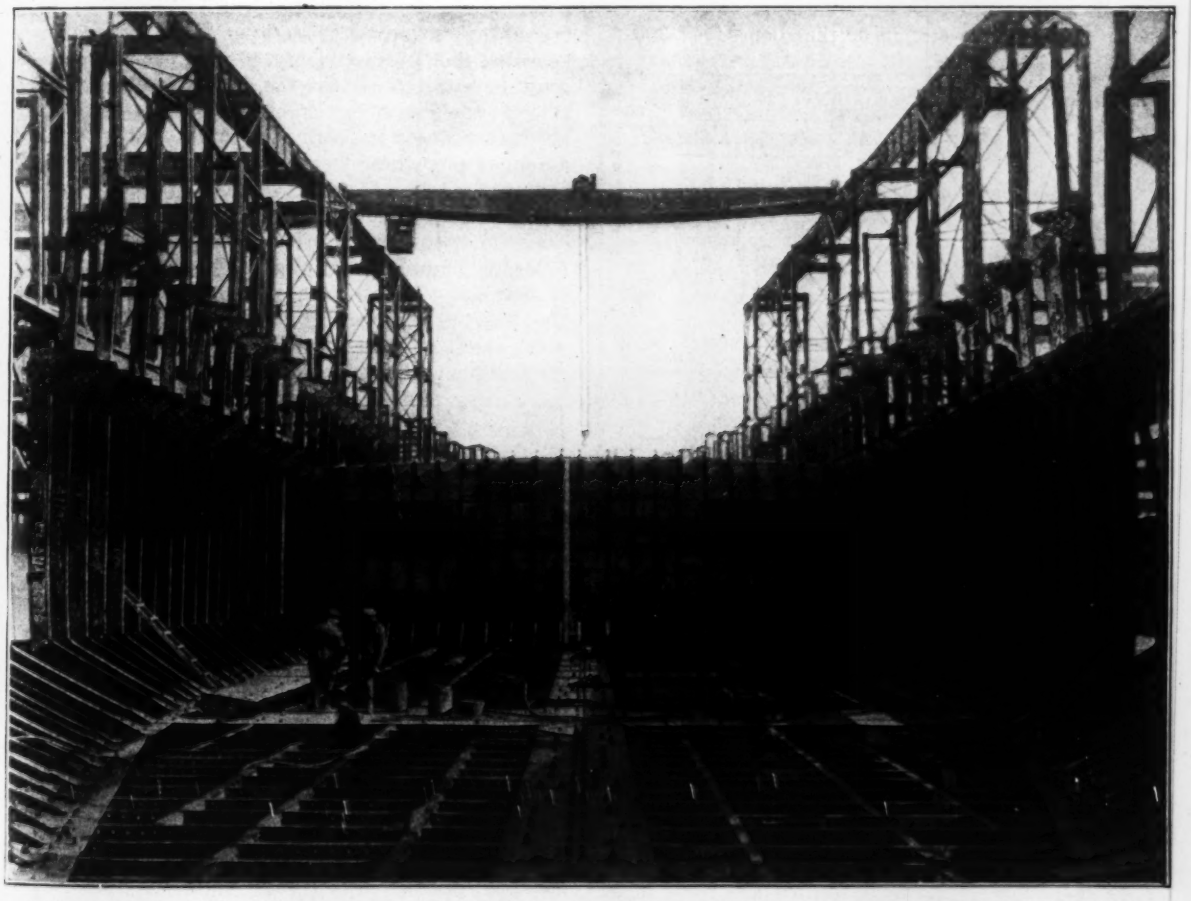


FIG. 1. AT SUN SHIPBUILDING COMPANY'S YARD CRANEWAYS 95 FEET HIGH COVER THE 80-FOOT WIDTH OF WAY; TWO CRANES ARE PROVIDED OVER EACH SHIPWAY

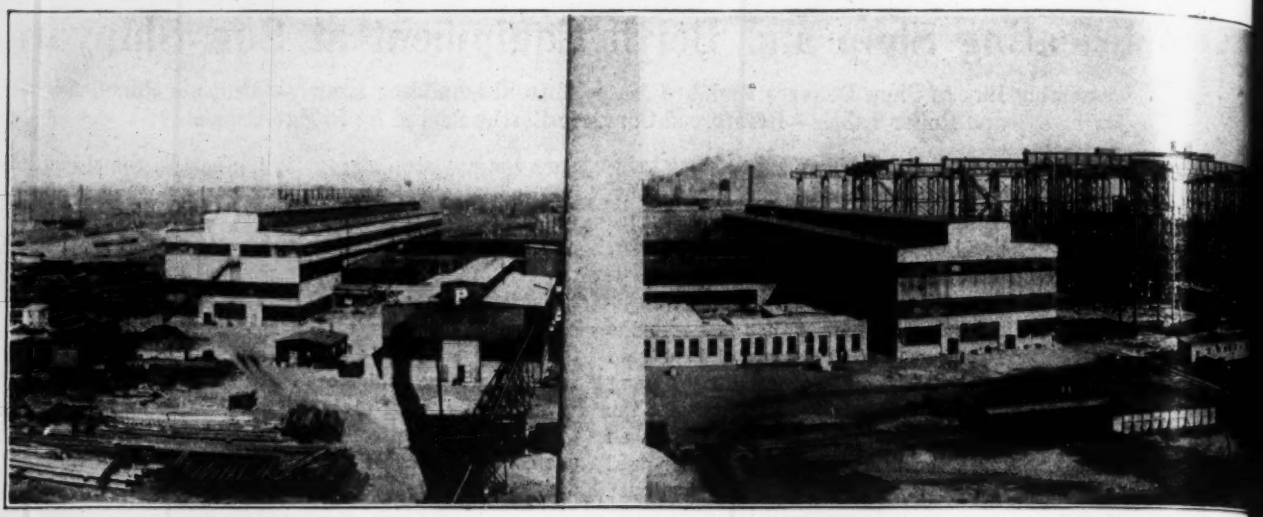


FIG. 2. LOOKING EAST TOWARD HULL CONSTRUCTION PART OF YARD SHOWS FABRICATING AND ASSEMBLY SHOP

spanning the full 80-ft. width of the bay and traveling its entire length. The fabricating portion of the building has no bridge cranes, but is equipped with a number of overhead I-beam trolley runways, and, in the plate side of the shop, extensively rollers beds for transferring plate.

Revision of the layout will consist in adding on the east side of the fabricating section a 115 x 300-ft. extension, making this section of the shop 340 x 300 ft.

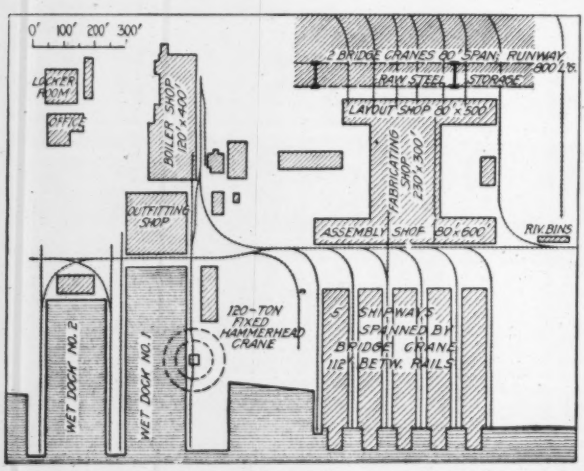

0' 100' 200' 300'
2 BRIDGE CRANES 80' SPAN; RUNWAY 600' ±
LOCKER ROOM
OFFICE
BOILER SHOP 80' x 400'
RAW STEEL STORAGE
LAYOUT SHOP 80' x 500'
FABRICATING SHOP 230' x 300'
OUTFITTING SHOP
ASSEMBLY SHOP 80' x 600'
RIV. BINS
120-TON FIXED HAMMERHEAD CRANE
5 SHIPWAYS SPANNED BY BRIDGE CRANE 112' BETW. RAILS
WET DOCK NO. 2
WET DOCK NO. 1

FIG. 3. GENERAL PLAN OF FIVE-WAY SHIPYARD FOR LARGE FREIGHT STEAMERS, SUN SHIPBUILDING

As indicated in the small sketch plans of the layout, Fig. 4, the addition will be devoted largely to furnaces and bending slabs, which will be moved from their present location separating the shape and plate fabrication. The shop as it now exists has ample plate capacity but inadequate shape capacity. The provision for straight shapes consists only of a single line of punches and shears along the east wall of the shop, with a longitudinal hoist trolley centered over the machines. Furthermore, the furnaces and slabs now separating the plate and shape sections not only interfered with any expansion of the shape-fabricating facilities, but also made it necessary to place a new plate multiple punch, acquired some time ago, in the layout shop. With the extension, and the furnaces and slabs accommodated there, the shape-fabricating section can be expanded as needed and room can be found within the area of the fabricating shop itself for the plate multiple and a new beam multiple.

The shop was designed for an ultimate capacity of 5000 tons of fabricated material a month. This would provide for a production of about 15 ships a year, counting 4000 to 4500 tons of steel per ship. It was thought, however, that a capacity of 150 tons per day per shift could be attained so that the day shift alone would be able to supply a production of 12 ships per year. It has not been possible to reach this output, but with the rearranged shop these figures should be realized.

Steady increase of the production of the shop has been recorded during the past season, through increasing efficiency of the working force. This is illustrated by the following figures for average daily output of the shop in four consecutive months, August to November: 180, 195, 222, 227 tons. All this is on two-shift work. The night shift has a materially lower output than the day shift, although the same number of men are at work and

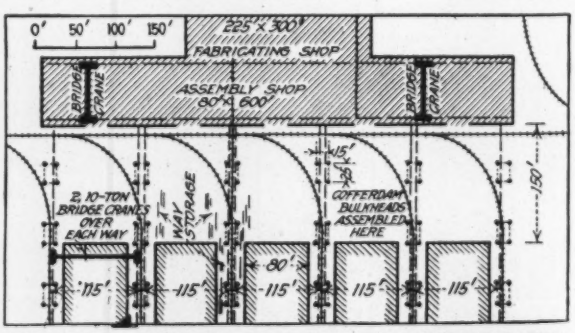
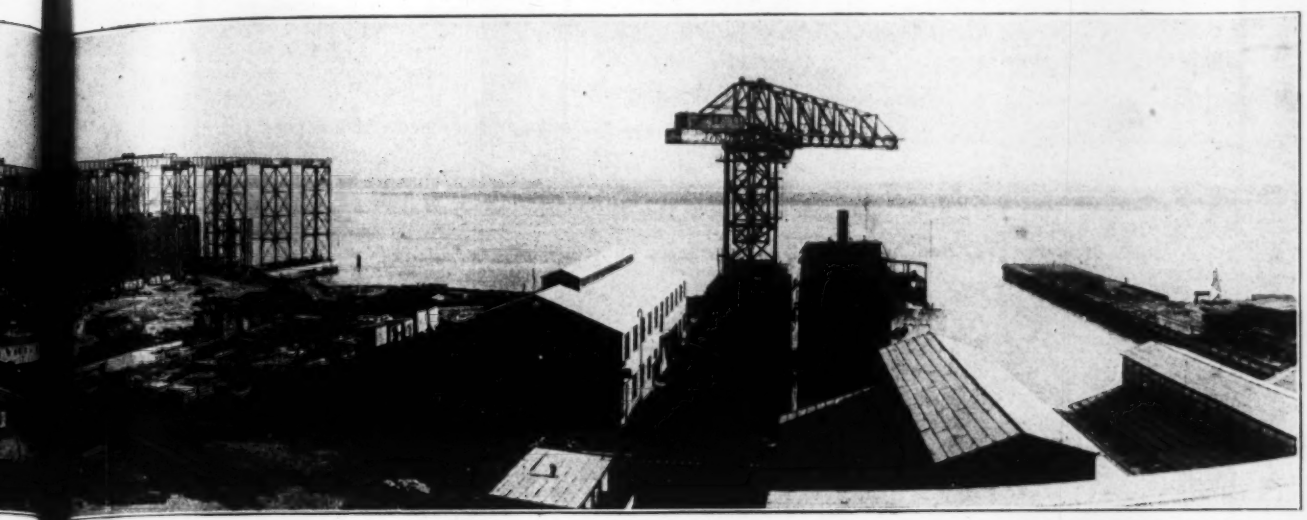


FIG. 4. SKETCH PLAN SHOWING RELATION OF FABRICATING SHOP AND BERTHS

Wet dock No. 2 is now under construction. Only the hull construction part of the yard is shown. An extensive machine shop and foundry plant belonging to the yard is located a quarter mile away

the working time is slightly longer. For November the total production of the day shift was 2866 tons and that of the night shift 1855 tons.

Handling Material Through the Shop—The roller-



(AT LEFT) AND SHIPBUILDING BERTHS WITH BRIDGE CRANES ON HIGH TRESTLES (IN CENTER) CLOSELY COÖRDINATED

bed equipment of the plate section of the shop can be seen in the view, Fig. 6. Originally these rollers served also for supporting and moving the plates at the punches, but during the past year ten Lysholm manually-operated punch tables have been installed, and the shop will be equipped with them throughout. A wide multiple punch is already in service, as indicated in the sketch plan, Fig. 5, and a 42-in. multiple punch for beams is soon to be installed. Material is supplied to the shop by way of six standard-gage tracks entering the landward side of the layout shop from the storage yard. The bridge cranes of the layout bay take material from the cars as delivered from storage, and transfer it as needed for laying out, straightening, etc. They deliver the material finally to the roller beds, the furnaces, or the hoist trolleys in the shape section. The extension of the shop now under construction will be equipped with a very complete system of overhead trolley runways, carrying in part electric hoists and in part hand hoists, and connecting with three transverse runways now in service in the plate section of the shop. With this handling equipment, all facilities for the movement of material through the shop will be supplied. The trolleys and roller beds deliver the fabricated material to the edge of the assembly bay, where it is taken up by the bridge cranes traveling along that bay.

All assembly bolting and riveting, from floors and frame brackets to bulkheads, is done in the assembly bay. This has proved a highly satisfactory feature of the original plan, though the officials state that an assembly area of twice the size could be used to advantage. The two 10-ton cranes in this bay suffice for handling assembled parts up to 20 tons in weight. This is enough to take care of all bulkheads (riveted up in half widths) except cofferdam bulkheads, which, with their stiffening girders, are assembled in the space between the shop and the head of the way.

Referring to the sketch plan, Fig. 3, it will be seen that there is a track along the outgoing side of the assembly shop and spur tracks leading out under the crane trestles along the shipways. These were laid out with a view to distributing much of the ship and other construction material down along the berths by railway cars, but the tracks have been used very little for such service, the bridge cranes proving ample for all handling.

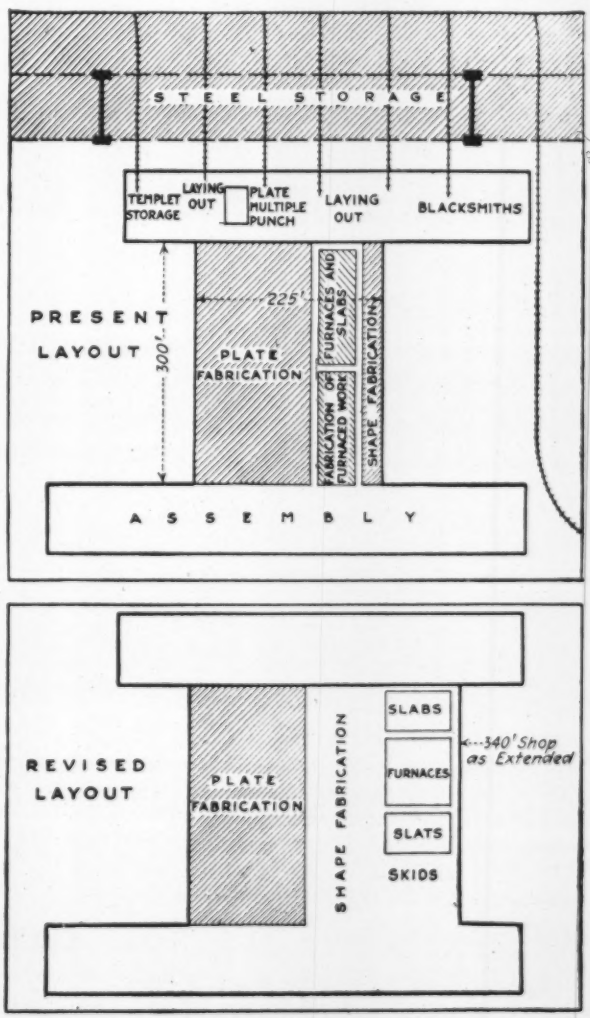


FIG. 5. EXISTING AND REVISED LAYOUTS OF FABRICATING SHOP

FIG. 6. ROLLER BEDS FITTED IN LARGER PART OF PLATE SECTION OF FABRICATING SHOP FOR EASY TRANSFER OF PLATE

Two Cranes Per Shipway—How the berths and cranes are arranged may be gathered from the view, Fig. 6, and the sketch, Fig. 7. The trestles are spaced 115 ft. on centers, allowing for an 80-ft. width of shipway, a trestle width of 15 ft., and 10 ft. of clear space between shipway and trestle. The trestles are built of towers 15 x 25 ft. in plan, spaced 50 ft. apart, so that the crane runway spans are alternately 25 and 50 ft. Each tower bent carries, by means of a transverse 30-in. girder, two crane run girders spaced 3 ft. apart and braced together for lateral stiffness. The crane girders in the tower spans are 30-in. I-beams, while the intermediate spans are 6-ft. plate girders.

The design of the shipbuilding crane runs, which is distinguished by the use of single H-sections for the columns and heavy sections for beams, up to 30-in. 200-lb. rolled girders for the transverse supports of the crane girders, was carried out by the Belmont Iron Works. The same concern designed and built the structure of the fabricating shop.

Small Way-Head Storage—Fabricated material completed in the shop—whether punched or assembled—is in part retained in the shop until wanted on the ship, and in part placed in storage at the head of the ways and alongside the crane trestles. The original intention was to take care of all this storage alongside the trestles, using the space at the head of the ways only for large assembly work, such as that of the cofferdam bulkheads. It has been found more convenient, however, to provide racks and stow material at the head of the ways, in small amounts. The heavy bulkhead assembly is carried on in this space, and stowage possibilities are therefore limited. It is expected that the way-head storage and supplementary storage along the trestles will provide for all requirements of equalization between shop and ship.

Reinforced-Concrete Berth Construction—What is virtually a copy of timber pile bent way construction was adopted by J. N. Pew, president of the Sun Shipbuilding Co., who is responsible for the principal features of the yard layout and construction. The Raymond Concrete Pile Co. designed and built the ways. Some essential details are shown in Fig. 8.

Over each pile a concrete column was molded. Transverse caps over the column bents, 80 ft. long over all, are connected by three longitudinal stringers near the center, and a spacer stringer along either side of the way. The center stringers are in the line of the keel blocks and the two launching ways. The transverse section in Fig. 7 makes their construction clear. For the rest, the bents are separate and wood flooring is placed over the caps to form a working surface. As the flooring is not fastened to the concrete the planks can be removed and replaced at any time.

At the site the present surface is all hydraulic fill. There was water over much of the present yard area at the time construction commenced. Hard bottom is found 25 to 45 ft. down, however. The piles were driven to a firm bearing in this. They were placed to develop a carrying capacity of 30 tons, or 50 tons at ½-in. settlement, but H. G. MacNees, plant engineer, believes that they would develop a 50-ton capacity with no appreciable settlement. The entire way structure

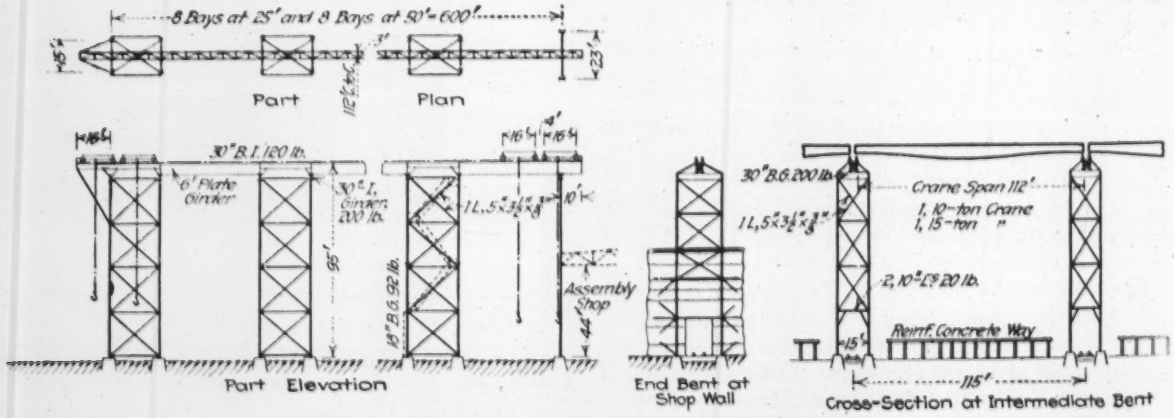


FIG. 7. SKETCH OF CRANE TRESTLES AND BERTHS

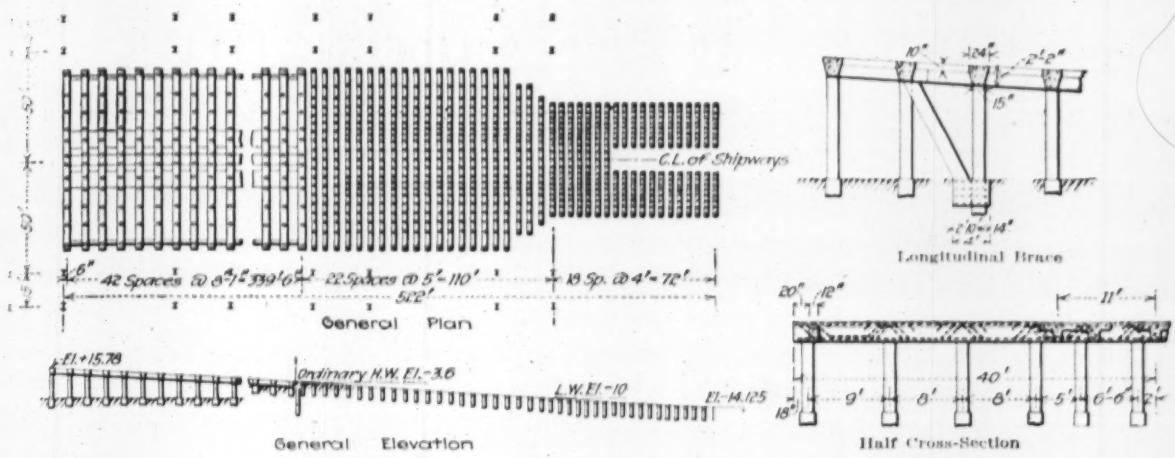


FIG. 8. CONCRETE PILE-BENT SHIPWAYS AT THE SUN SHIPYARD

is set on an $\frac{1}{6}$-in. slope, this inclination being the launching slope.

Excellent service has been given by these berth structures. No damage or settlement of any kind has been noticed. The principal change that has been made is the addition of a short timber platform blocked up directly on the ground, at the head of the ways, to form an extension for a longer ship than could be accommodated by the ways as originally built.

From high-water level down, the ways are wholly of timber construction, and consist of separate transverse bents of piles spaced 5 ft. on centers, for a total length of 182 ft. outward of the lowest concrete bent.

Storage Yard Rearranged for Bridge Crane Service—As originally planned, the area back of the fabricating shop was to be used for storing raw steel by flat piling on mud sills, the material to be handled by locomotive cranes from cars into storage and from storage into

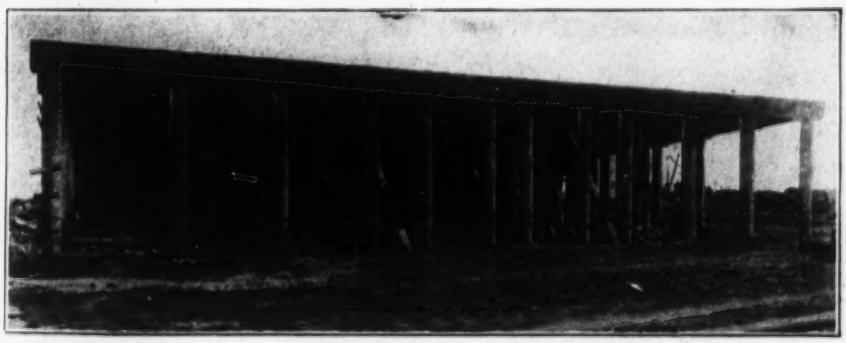


FIG. 9. ONE OF THE CONCRETE WAYS JUST AFTER CONSTRUCTION WAS COMPLETED, BEFORE PLANK FLOORING WAS PLACED ON CRANE RUNAWAYS

shop. A year's experience with this system made flat piling appear unsatisfactory, and racks were built. The final working out of the rearrangement is represented at present by a complete rack system covered by a bridge-crane runway spanning 80 feet and 800 feet long.

The standard rack developed for this yard consists of a 12 x 12-in. base timber to one side of which are bolted 6 x 4-in. angle standards, spread about 24 in. at the bottom and about 10 in. at the top, where they are conected by a gusset plate. These standards are stiffened by a short length of 8-in. channel at mid height. No longitudinal connection between parallel members of the rack is used.

Wet Dock Being Duplicated—The present wet dock is an excavated basin, 200 x 600 ft., walled by concrete retaining walls on pile-supported timber platforms. It is served by a fixed McMyler-Interstate hammer-head crane of 120 tons capacity. The machine is fitted with an auxiliary hoist of smaller lifting capacity. Engines and boilers (Scotch) are set in the ship here. The hammer head crane does all minor handling at the fitting-out dock also, no other lifting machines being provided.

To increase the dock capacity, a second basin, 100 ft. shorter, is now under construction immediately to the west. This will be served by a locomotive crane on portal base, of light load capacity but with fast motions, for handling general fitting-out work. The heavy lift will still be handled at the hammer-head crane, as described. The Sun Shipbuilding Co. was formed as an offshoot of the Sun Oil Co., whose main plant is only a few miles farther down on the Delaware River. Building large tank steamers for the oil company was the principal business at the start. Orders soon came for large cargo steamers, however, and the present program of construction at the Sun yard includes mainly cargo steamers. As already stated, the yard was planned and is being operated as a specialist institution for vessels of about 10,000 tons. For 1919 the intention is to work the yard at a rate to produce 18 ships in the twelve months. This means a building time of 100 days per ship. Such a rate of working could now be realized except for the fact that the fabricating shop has not reached full output capacity.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

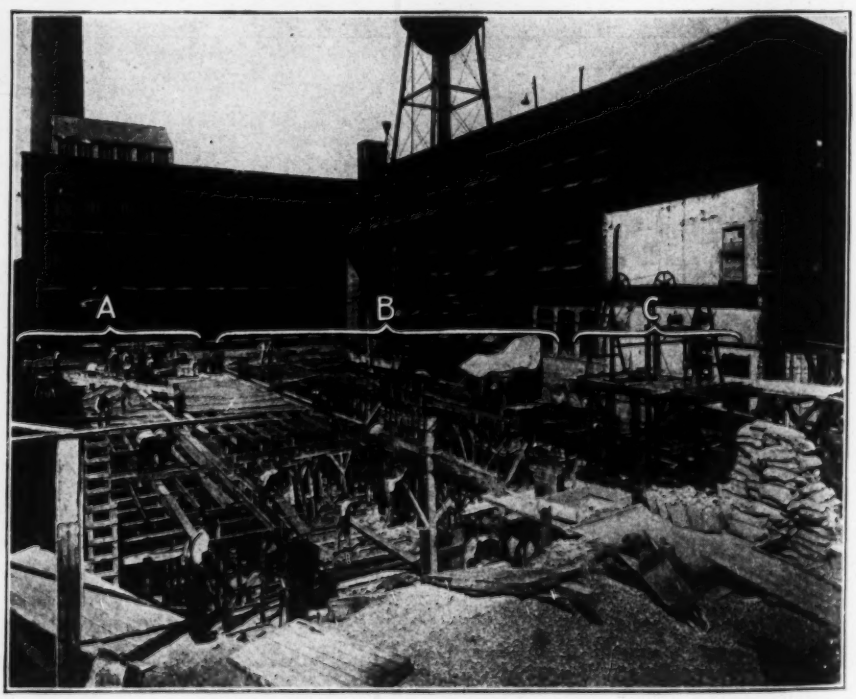
Close Sequence of Operations Cuts Construction Time

Caissons for War Work Factory Started as Soon as Steam Shovel Clears Sites—Construction Crews Scheduled to Crowd Each Other

CREWS purposely scheduled to crowd close on each other's heels were employed to speed construction on a concrete factory recently completed in Chicago. Occasionally, a crew was started even before work was ready for it, so as to increase the progress of the crew ahead. Clamoring for right-of-way, the concreting gang pushed the steel men and the steel men crowded the form carpenters, and behind all drove the contractor, with materials supplied and construction plans laid out well ahead of the best speed the workmen could reach.

War contracts required the completion of the building in four months. The ground dimensions were 108 x 76 ft. and the height was seven stories. The foundations were 24 open caissons sunk to rock at a depth everywhere less than 50 ft. Square outside columns and round interior columns carried longitudinal girders, between which were concrete joist-and-tile-fill floors of the Johnson type. A two-story building occupied the site. This had to be removed and a basement excavated. The work was let for a lump sum. Labor supply was the great problem, since war industries were offering workmen bonuses and unlimited overtime on percentage jobs.

Close sequence of operations was the plan devised to meet the speed requirements. As soon as a corner of the old building was wrecked, a steam shovel started excavating the basement, and as soon as the steam shovel had cleared sufficient space a single caisson was started. Caisson sinking proceeded by usual methods, except that, owing to quicksand and water, a large part of the lagging had to be driven and the wells were driven one at a time, using a hand windlass, as fast as the shovel cleared the site, instead of waiting until the general excavation had proceeded far enough to allow an engine to be rigged up to carry a number of wells at once. By this plan, the caisson work kept close behind the shovel, and the foundations were finished in prac-



FLOOR CONCRETING BEGUN BEFORE LATEST FOUNDATION CAISSON WAS FINISHED ON CHICAGO FACTORY

A. First-floor girder being poured in this corner, by use of temporary portable mixing plant. B. Form building and steel placing in all stages of progress proceeding in space between. C. Last foundation caisson being sunk in this corner.

How much would you have saved?

When you figured how much that new "stunt" saved you last year, did you stop to think how much more it would have saved if you had tried it out the year before?

By telling about it in ***"Hints for the Contractor,"*** you and the "other fellow" may both be "in" just that much next year.

All contributions used will be paid for.

tically the same time as was the general excavation. As fast as the caissons were ready, the foundation girders under the basement floor were concreted. At the same time, the adjacent building was shored. Retaining wall work followed as rapidly as the way was cleared for the forms. As shown by the view, slightly over one month after construction was started the old building was wrecked, the general excavation was completed, all but one caisson had been excavated and concreted, the foundation girders and the retaining walls were finished, concreting was in progress on the first floor girders, and column steel and floor forms were in various stages of erection. The view shows how close the sequence of operations was. It shows the last caisson being sunk in one corner, and the first floor slab being poured in the other corner. The procedure outlined saved two or three weeks' time at the start of the job.

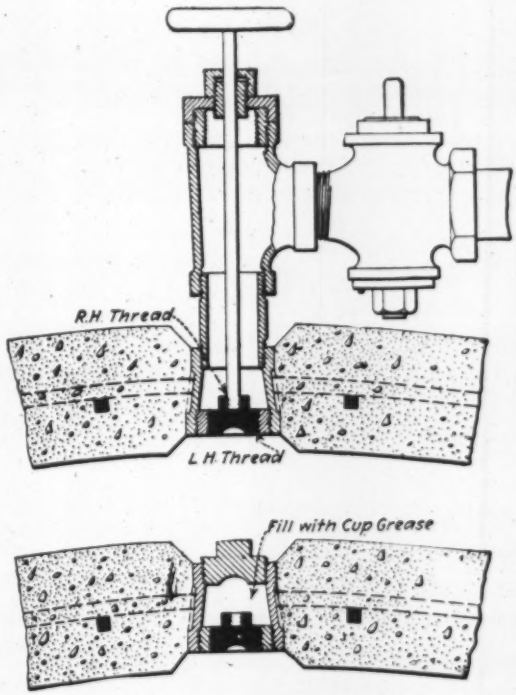
It was decided to handle the concrete by spouting from a tower at the end of the building to a hopper at the center of each floor, and to deliver the concrete from the hopper to the forms by carts. The ¾-cu.yd. mixer for the tower plant was used first for concreting the caissons, and was busy on this work until after the first floor concreting was begun. A small portable mixer was, therefore, installed temporarily to concrete the first floor and the retaining walls until the larger machine was free and the tower could be erected and the spouting strung.

Concreting of columns and floors followed the same close sequence as characterized the operations on the foundations and basement. As soon as carpenters had a section of floor forms ready, bridgemen were started laying steel and masons placing tile, and the concreting gang followed close behind. Each crew was kept close on the heels of the crew ahead, crowding it to get it out of the way. Often a gang was started even before the gang ahead was ready for it to take up the work. The fact that the job was war emergency work was kept constantly before the men. Constant pressure on the workmen by the means outlined was the secret of the progress made.

The building was designed by Holabird & Roche, architects, Chicago. Avery Brundage was the contractor. The contractor's superintendent was W. G. Nelson. Bauer & Black, Chicago, are the owners.

Service Connections to Concrete Water Mains

METAL pipe fittings, such as are kept in stock, can be used in making service-pipe connections to concrete pressure pipe for city distribution lines, by a device recently developed by the Lock Joint Pipe Co., Ampere, N. J. Malleable iron couplings are embedded in the original pipe when cast, as shown in the illustration. The inner end is fitted with a bronze plug inside of a malleable iron bushing. The outside end is fitted with a plug of malleable-iron, and the space between them is filled with grease. When everything is in readiness for connections, the outer plug is removed and the plug on the inner end is unscrewed by means of a stem inserted through a T, as shown in the sketch. The plug is then

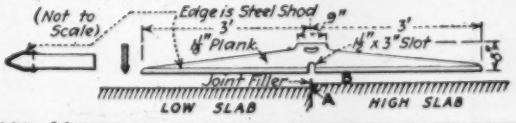


REGULAR STOCK PIPE FITTINGS ONLY USED IN MAKING THIS CONNECTION

raised to and screwed into a faced bushing at the top of the T. The stem is unscrewed, along with the packing nut and perforated cap, and a solid cap is screwed on the faced bushing at the top. No tapping machines are required, and the excavation need be carried only to the top of the pipe.

Split Straightedge Corrects Joint Humps In Concrete Pavement

HUMPS in a concrete pavement due to high slabs at joints are prevented in Wisconsin road work, according to F. M. Balsley, division engineer of the Wisconsin Highway Commission, by the use of the split straightedge shown by the drawing. Owing to the projection of the joint filler above the slabs, the strike



STRAIGHTEDGE TO MAKE CONCRETE PAVEMENT JOINTS EVEN

board cannot be swept across the joint, and frequently, when it is lifted to start the next slab, exact elevation is not secured. The result is a high slab, as indicated by the drawing. Use of the split float at the joint will bring the edges of the two slabs to a common elevation, as at A, in the diagram, but there will still be a hump, as at B. The split straightedge, applied as indicated by the diagram, permits the detection of this hump or other irregularities in the planes.

The construction of the straightedge is simple. A 1¼ x 8-in. plank is cut as shown, and the edge is beveled sharp and shod with sheet metal.

NEWS OF THE WEEK

New York, January 2, 1919

American Engineering Success in War's Test

Accomplishments by Engineers Cited to Rebuke Recent Utterances on Need for Training

That American engineers have succeeded in impressing the general public by the success of their work in the great war's crucial test is demonstrated by the comment of the Philadelphia *Public Ledger* in a recent editorial. This comment is so illuminating and informative that it is reproduced, as follows:

"This seems to be an odd moment for the recent pessimistic utterances of one of the professors at the Massachusetts Institute of Technology on the need of better training in all our engineering schools. For the fact is, not only have the professional engineers and their associates from West Point and Annapolis and all their amateur assistants who went into the Army and Navy covered themselves with glory in the war, but at this very moment, when the English University Commission has started back for home, its farewell opinion is more than usually flattering to American collegiate and university education. Moreover, what it particularly admired and marveled at was the splendid equipment of the technical schools and the physical laboratories in our larger institutions. In this it but confirmed English opinion as expressed in the friendly report of Alfred Moseley's unofficial commission, which made a survey of engineering training and practice in this country about a decade ago, a report that was a great tribute to the American trained engineer and to American schools.

"But if any confirmation of the value of the American engineer and of the technical training that has given him an efficiency recognized everywhere be needed, it will be found in Prof. William M. Sloane's brilliant account of his experience with the leading German magnates when he was one of our exchange professors. In his inimitable way, Professor Sloane has told how these German specialists fumed at the mouth because the American engineers were successful and beat the German engineers, when from the Prussian point of view, such a thing ought to have been impossible, since America was a wretched country, without standards of education and without individuals possessing any capacity for science or Kultur.

"Well, as the very modest recent report of President Vail, of the American Telephone and Telegraph Co., shows, in his discussion of the new

(Concluded on page 66)

Wide Building Campaign Involving Billions About To Be Started by Government

"Build Now for Better America" Is Slogan of Department of Labor in Beginning Movement

(Washington Correspondence)

A great building campaign, involving the construction of highways, public works of other character, homes, and public utilities, is about to be undertaken by the Government, largely for the purpose of making certain that employment will be found for demobilized soldiers.

An organization to conduct the campaign is now being created in Washington, with headquarters at 16 Jackson Place, under the general supervision of Secretary Wilson of the Department of Labor, and with the coöperation of the American Federation of Labor and other labor interests. The following slogan has been adopted:

"Build now for greater and better America. A billion for roads; two billions for public works; three billions for a million new American homes. What are you doing to help this campaign?"

City Officials Urged To Build

The Department of Labor, as one of the first steps in the campaign, is sending the following message to wage earners throughout the country: "Use your influence with your city fathers, your selectmen and other town officers to start at once municipal and town improvement." Cities and towns are being urged to build school houses, engine houses, roads, canals and other improvements. To those who believe that the cost of building will be less in a few years than it is now, the Department of Labor is replying that "probably 95% of the cost of a residence ultimately goes to labor whenever a house is built, so that the cost is almost immaterial to wage earners as a class."

Secretary Baker of the War Department is coöperating in the campaign, and has sent telegrams to the Governors asking them to urge in inaugural messages the immediate resumption of building of every character.

One of the first branches of the new activity of the Government to be organized is the "Own a Home" branch, which has been placed under the direction of the Information and Education Service of the Department of Labor, of which Roger W. Babson is chief. Mr. Babson is creating an organization of assistants, headed by Franklin T. Miller of New York City.

One of the arguments being used in favor of the "Own a Home" movement is the figures as to increase of population. The population of the United States normally increases, exclusive of immigration, by 3,000,000 persons annually. At this rate the population is supposed to have increased by 6,000,000 during the past two years, during which the building of homes has been largely suspended. It is estimated that it is necessary to build 315,000 homes each year to meet increased housing needs, and that the building of 630,000 homes is necessary now. Secretary Wilson's statement is as follows:

"I am of the opinion that from the time we restore ourselves to our normal post-war activities, the demand for peace-time production will be so great that there will not be the remotest possibility of securing any reduction in the wage rates from their present basis. I feel further, that the manufacturer who fails to take into consideration the prospects of the future and who, in a hope of securing a cheaper labor or cheaper raw material, does not build up his organization and maintain it during the possibly brief period of readjustment, will be handicapped in securing his share of the business afterward; because he will be handicapped through lack of working forces in his factory.

"It therefore seems to me that the situation resolves itself into taking care of the possible problem in the interim between our ceasing war activities and the time when we have assumed our natural post-war activities.

Labor Reservoir Suggested

"With the attitude of mind that I have expressed as existing on the part of some manufacturers relative to waiting for a lowering in the price of raw material and the price of labor, it may be that the restoration of industry will not take place as rapidly as the demobilization takes place. We are not sure of that. There ought to be provision made for a reservoir that would absorb the demobilized workers and the demobilized soldiers, not in doing the things which there is no need to have done, but in doing the things that ought to be done—that are valuable for peace-time purposes—a reservoir that will take care of them for the brief period between their dismissal from the Army or their dismissal from the war

industries until they can be reabsorbed into the natural post-war industrial activities.

"The Department of Agriculture is taking steps to accomplish part of that purpose in the matter of road improvement, highway improvements, on the theory Congress has acted on in the past, that for military purposes and for postal routes roads are necessary all over the country. Where men are employed in road-building, they do not have to be taken from their own home communities to engage in the work. The Department of Agriculture, therefore, has asked or is about to ask for an increased appropriation which will enable it, in coöperation with the respective states, to engage in a nation-wide project of road-building that will absorb, if need be, some of these workers temporarily, until industry resumes its natural course.

"During the period of the war, because of the shortage of workmen, there has been little or no municipal activity in building operations, in park extensions, in sewer extension, waterworks, or any other of the public utilities. They have been delayed and postponed because of the shortage of manpower and because of the inability to finance them. We are suggesting, through the Department of Labor, to the various municipalities throughout the country, the advisability of their resuming these activities at as early a date as possible.

"Whenever it is possible to utilize public means, wherever it is possible to undertake public work, or things that are valuable for peace-time purposes, they should be undertaken as promptly as possible."

Colleges To Train Reserve Officers

With the demobilization of the Students' Army Training Corps, various colleges of the country will turn their attention to the Reserve Officers' Training Corps. Before the war there were about 115 units of the latter, in as many colleges. About 100 of these are being reëstablished and applications have been received for the formation of about 200 new units.

Secretary of War Baker announces one important change in the organization which is now being worked out to allow the units to specialize in training officer material for the field artillery, engineer, signal, coast artillery, ordnance, medical, and military aëronautics corps, instead of the uniform training for infantry, which was the rule before the war.

The administration of the Reserve Officers' Training Corps has been placed in the hands of the Committee on Education and Special Training. The committee will attempt to make available a large amount of scientific and technical material which has been developed by the experience of the war, and in all units special emphasis will be placed on physical training and mass athletics.

Government Concrete Ships Now Building

Owing to Cancellation of Some Contracts Big Ships Have Been Cut From 42 to 14

In *Engineering News-Record* of Sept. 5, 1918, p. 471, there was published a list of Government concrete ships then contracted for. That list has since been curtailed, so that at present the tabular statement represents Government concrete shipbuilding at the end of 1918. The cut is entirely in big ships. Instead of 42 vessels, mainly of the 7500-ton class, to be built in the agency yards, the Emergency Fleet Corporation is reducing contracts to 14, distributed as shown in the table. In addition, there are a number of barges under construction for private account, though there is no record of any private ships being built.

TABLE SHOWING GOVERNMENT CONCRETE BOATS UNDER CONTRACT

Government Agency	Type of Boat	No.	Name of Contractor	Location of Yard
Emergency Fleet Corporation	3500-ton Freighter	1	Fougner Concrete Shipbuilding Co.	Astoria, L. I.
	3000-ton Freighter	1	Liberty Shipbuilding Co.	Brunswick, Ga.
	3500-ton Freighter	2	Liberty Shipbuilding Co.	Wilmington, N. C.
	7500-ton Tankers	2	San Francisco Shipbuilding Co.	Oakland, Cal.
	7500-ton Freighter	1		
	7500-ton Tankers	2		
	7500-ton Freighter	1	F. T. Ley & Co.	Mobile, Ala.
	7500-ton Tankers	2	A. Bentley Sons	Jacksonville, Fla.
	7500-ton Tankers	2	Scofield Eng. Co.	San Diego, Cal.
Navy Department	500-ton Harbor Lighters	4	Ambursen Consn. Co.	Little Ferry, N. J.
	500-ton Harbor Lighters	4	L. L. Brown Co.	Peekskill, N. Y.
	500-ton Harbor Lighters	4	S. H. Beskin	Beacon, N. Y.
Railroad Administration (Construction Supervised by E. F. C.)	500-ton N. Y. Barge Canal Barges	8	Holler-Davis & Flood Co.	Fort Edward, N. Y.
	500-ton N. Y. Barge Canal Barges	4	Caldwell-Marshall Co.	Tonawanda, N. Y.
	500-ton N. Y. Barge Canal Barges	5	Grayhaven Shipbuilding Co.	Detroit, Mich.
	500-ton N. Y. Barge Canal Barges	4	Cummings Structural Concrete Co.	Ithaca, N. Y.
War Transport Branch, War Dept.	130-ft. River Boats	9	(Contracts not completed)	
	100-ft. Water Tankers	5	Gt. Northern Sbldg. Co.	Vancouver, Wash.
	265-ft. Car Floats	6	Liberty Sbldg. & Transp. Co.	Cleveland, O.
		6	L. B. Harrison Co.	Athens, N. Y.

The status of construction in the large ships is as follows:

At Wilmington, N. C., there are under construction two 3500-ton concrete cargo ships on molded lines. The yard, with two ways, was completed sufficiently to start the construction of ships about Oct. 15. The outside forms of one ship are practically complete, and part of the steel has been placed. On the second ship the outside forms are about 40% erected. There has been some delay in construction in this yard due to the change in the Shipping Board's program, which originally contemplated the building of both tankers and cargo ships in this yard.

The present program of the Shipping Board contemplates the construction of two 7500-ton tankers at Jacksonville. Construction work upon these two ships was started about the middle of November. The outside forms are practically completed on both ships, and some steel has been placed in both ships. The first concrete will be poured about Feb. 10.

At the Mobile yard the construction of two 7500-ton concrete tankers and one 7500-ton cargo ship is now contemplated by the Shipping Board. The construction of the two tankers was started the latter part of October. About 30% of the steel has been placed. The inside forms have been made and partly erected. First concrete will be poured in January. The cargo ship will not be started until after the first tanker has been launched.

The San Diego yard is building two 7500-ton concrete tankers. Construction on these was started early in December. Outside forms are now practically completed, and some steel has been placed. The first concrete will not be poured until the latter part of January.

Two 7500-ton concrete tankers and one 7500-ton cargo ship are to be built at San Francisco. The construction on the two tankers was started the middle of October. The outside forms on both ships have been completely fabricated. About 60% of the steel has been placed. The inside forms are built and partly erected. The first concrete will be poured in January. The construction of the cargo ship will not start until the first tanker is launched.

The Brunswick ship has been launched and the Fougner ship is nearly ready to launch.

The status of construction of the canal barges is as follows: Concreting has been completed on eight barges. Five are now in the water and 19 of the 21 under contract are either completed or under construction. Of the other boats, three of the Navy barges have been delivered, two of the Army car-floats have been poured, and one water-tank steamer has been poured.

Army Will Sell Horses and Mules

Contractors who need horses and mules may be able to get some cheap at auction sales of surplus animals to be held at the various camps and cantonments during January. The schedule calls for four sales, Jan. 7, 14, 21 and 28, at which a total of 44,455 animals will be sold. These will include cavalry horses, artillery horses, draft horses, mules and pack animals.

American Engineering Success in War

(Concluded from page 64)

multiplex device for 'phone and telegraph, the invention, one of the greatest ever made, was not the freakish discovery of one mind, but the result of the team work of hundreds of men on the company's technical staff. Not only that, but suggestions from men trained at Annapolis and West Point also proved helpful. In other words, the discovery was the result of the high equipment of the average American trained in the average school of technology or in that of trade experience. And one naturally mentions this multiplex discovery, since, taken in connection with the resourcefulness and initiative which mark so much of the college-trained, school-trained and shop-trained Americans on the battlefield in which they completely outclassed their German opponents, it is a feather in our cap and calls for some little reassurance, if not complete optimism, as to the American methods of the present.

"Moreover, the English engineer has also shown up well in war, although Germany despised the English experts for years and also had a poor opinion of the Frenchman's ability. And yet the English tanks, the French baby tanks, the French guns, to say nothing of the supreme French airplanes—and also not forgetting the Italian engineers and mechanicians who reached an almost super-excellence—have all achieved wonders in the war and beat the Germans point by point in every line of action.

"The fact is, we must stimulate our own and we must increase our facilities for training engineers and for reaching down and connecting and gearing up the various engineering trades with the technical colleges and universities. But while it is quite right not to relax or fall back, at the same time we should take a little satisfaction in the evidence that the German system of education and the state-commanded scheme of a standardized universal Kultur has proved a failure so far as the question of developing men with initiative and individual resourcefulness is concerned. That our laboratories are likely to attract English students is another thing we can take to heart with comfort. Aside from this, it is clear that as civilization in the future will demand more of the engineer than ever, this demand our schools and colleges must meet. That they will no one can doubt. And as a sort of first instance, the recent reorganization of the Yale Graduate School, by which the Sheffield Scientific School and the Arts are grouped under a common head, with an increase of the undergradute scientific course from three to four years, is proof of the pudding."

Six Highway Bills Introduced in Congress During December

Besides the $1,000,000,000 highway bill introduced by Senator Smoot (as reported in *Engineering News-Record* of Dec. 26, p. 1198), five other road bills were introduced in Congress during December. While Senator Smoot's bill provided for a complete reorganization of highway administration by the Federal Government, the other bills aimed at utilizing present agencies and were either amendments to the present Federal-aid highway law or utilized the organizations of the War and Post-office Departments. A joint resolution was also introduced, which provides for the handing over to the Secretary of Agriculture by the Secretary of War of such war material as may be used in highway construction work.

Senator Smoot's bill provides for the formation of a United States Highway Commission, to be composed of the Chairman of the Senate Committee on Postoffices and Post Roads, the chairman of the House Committee on Roads and the Director of the Bureau of Public Roads. It proposes to issue bonds to the amount of $1,000,000,000, the proceeds of which will be distributed to the states in proportion to the average percentage of their percentages of population, total assessed valuation, and total mileage of public highways. When money is supplied to the states, they must deposit state bonds, drawing interest at 4%, to cover the amount advanced to them. The 4% interest shall pay the 3% rate on the United States highway bond issues, and also establish a sinking fund to pay for these bonds. Long-time payments are provided for the state bonds. It is further provided that the Federal Government shall pay yearly to the depositing states 2% of the amount deposited, to be expended in maintenance.

Of the four bills providing for the utilization of the present Federal highway administration, those by Senator Bankhead, and Senator Swanson, in the Senate, and Representative Browne in the House of Representatives, are practically identical. They are in the form of amendments to the present Federal-aid highway law and consist of a change in wording to permit a wider interpretation of the words "post road," to cover any road that might so be used. They also provide for the appropriation of $50,000,000, to be immediately available; $75,000,000, available July 1, 1919; $75,000,000, available July 4, 1920; and $100,000,000, annually to July 1, 1924. Another bill, introduced by Representative Shackleford, provides for a similar change in wording and for an appropriation not to exceed $150,000,000 per year.

The other bill was introduced by Senator Swanson, and provides for the setting aside of 50% of the net proceeds derived from the operation of motor trucks engaged in carrying parcel post, to be expended in the survey, construction, reconstruction, improvement, repair, maintenance and administration of such highways as might be selected by the Postmaster General for the transportation of mail.

Criticisms of Chicago Paving Administration Retracted

Some time ago Prof. Ira O. Baker, of the University of Illinois, made a report on pavements in Chicago (see *Engineering News* of Dec. 7, 1916), which contained criticisms of the engineers and inspectors of the Board of Local Improvements. Some of the statements made in this report were shown on investigation to be based upon incorrect premises, and the following statement was obtained from Professor Baker of the Illinois Society of Engineers:

"Under date of Nov. 20, 1916, I forwarded to the Committee on Finance of the City of Chicago the manuscript of a report entitled "Report on Pavements Recently Built by the Board of Local Improvements of the City of Chicago." That report implied that there had been a considerable shortage in the thickness of all concrete foundations of pavements, and also in the thickness of the binder course and of the wearing coat of all sheet-asphalt pavements, which statements have been strongly objected to by the engineers of the Board of Local Improvements.

PAVEMENTS EXAMINED REPRESENTATIVE

"In preparing those parts of my report, I inquired specifically of the engineers of the technical staff as to whether or not the inspectors selected pavements of particular contractors, or pavements that were known to be faulty, and received an answer that convinced me that the pavements examined by the inspectors were fairly representative. I next inquired of the staff whether or not the summary of observations by the inspectors included all the observations made, and I was informed that they did. I asked for the inspectors' reports, and compared them with my report and found them to agree with the summary which the staff had furnished me.

"I had no reason for believing that my report was in error in any of these three matters, until I heard the testimony of one of the inspectors during the progress of the investigation conducted by a board appointed by the Chicago Civil Service Commission, Mar. 5-9, 1917. I then learned for the first time that, if the inspector found any defects in a pavement, he prepared a somewhat elaborate report from his field notes and filed that report; but, if he found no defects, he filed no report thereof. The data furnished to me were a summary of these special reports, and did not include any statement that other pavements had been inspected and found to be according to the specifications.

"All of my intercourse with the staff engineers convinces me that their only desire was to have the facts correctly presented, and I feel quite sure that they were entirely innocent of wrong intention in the matter.

"It is plain that as a number of observations were made and defects found

in only some cases, it was wrong to assume that the observations in which defects were discovered were representative of all the work done by the board during that season. I am very sorry that my report was not correct in these particulars; and am sorry to have made erroneous statements which have been considered as reflecting upon the honor of engineers of the Board of Local Improvements. I intended no such reflection.

"Public acknowledgment of the errors in my report has been delayed for a year and half on account of the fact that three investigations of the report have been pending. I believed, that, awaiting the outcome of these investigations, any statement concerning the matter by me might be considered as an attempt to forestall the verdict of the investigating body. I do not think that the delay in this acknowledgment has done any serious harm, since in the investigation conducted a year and a half ago by the board appointed by the Chicago Civil Service Commission I freely acknowledged my error, and since the findings of that board have been given wide publicity.

"IRA O. BAKER."

Louisville Club To Draft Bill For Licensing Engineers

The Engineers' and Architects' Club of Louisville, Ky., at its December meeting, unanimously passed a resolution providing that a committee of three be appointed to draft a bill licensing engineers and architects, and submit the draft to the board of direction. Then it is to be sent to every engineer and architect in the state of Kentucky of whom the committee can learn—including consulting engineers and architects and men holding salaried positions—with the request that the men addressed indicate whether they are in favor of licensing engineers and architects, and if so, that they suggest any desired changes in the bill as drafted.

The resolution also provides that the committee shall make such revisions in the draft as it may deem wise, submit it to the board of direction and then to the club, and, after approval, that a copy be sent to every member of the Kentucky legislature with the request that the bill be passed, and with a statement of the number of men in the state who expressed an opinion for or against the bill.

Rivers and Harbors Bill Reported

The current rivers and harbors bill, reported to the House of Representatives Dec. 21, contains items totaling $27,000,000, made up, practically, wholly of the usual project improvements. Large items are $4,000,000 for continuing the East River improvement at New York City, $2,500,000 for the Delaware below Philadelphia, and $3,000,000 for the Chesapeake & Delaware canal.

Wood-Preserving and Tie Men To Meet in St. Louis

The 15th annual meeting of the American Wood Preservers' Association will be held in St. Louis, Jan. 28-29. On the following two days a meeting of the tie producers of the country, to effect a national organization, will be held under the auspices of the tie and timber division, St. Louis Chamber of Commerce, in order to bring together both producers and users of cross ties.

In order to correlate the programs of the two bodies, the meeting of the American Wood Preservers' Association has been curtailed to two days, with three sessions on the first day and two on the second, concluding with a joint dinner with the National Tie Producers' Association. A session on the first day of the meeting will be devoted to consideration of the preservative materials situation, and a session on the second day to the tie problem.

War Committee on Technical Societies Handled Many Problems

As stated in the final report by D. W. Brunton, chairman, before its disbandment on Dec. 31, the War Committee on Technical Societies coöperated with the Naval Consulting Board and issued two bulletins, one on "The Enemy Submarine" and one on "Problems of Aëroplane Improvement." Before these bulletins on concrete problems were issued, only four-tenths of one per cent. of the matter received was adjudged by the committee of technical examiners to have sufficient merit to go before the final examiners of the Naval Consulting Board. Since that time the percentage has risen to 4.7%. The material received ranged from airplane superchargers and fuel for high altitude flying down to submarine detectors and depth bombs; from long-range guns to trench knives; from observation balloons to tunneling machines, and from caterpillar tanks to radium sights. More than 110,000 ideas, suggestions and inventions were received and passed upon by the Naval Department and the Naval Consulting Board, either separately or conjointly, while the Inventions Section of the General Staff, which is a much younger organization, has already handled over 25,000.

The inventions received may be roughly divided into four classes: (1) Those which have no intrinsic or suggestive value; (2) those which, while having no real value in themselves, suggest new lines of thought and investigations; (3) inventions which have considerable promise, but are not yet developed to a point where it is possible to pass judgment on them, and (4) inventions which are sufficiently perfected so that they can be investigated and tested. Ample facilities for testing inventions of the fourth class are provided by the Bureau of Standards and the Bureau of Mines, in Washington. The ideas, suggestions and inventions belonging to the second and third classes are, of course, much more numerous, and the necessity of providing some means for solving problems and developing inventions has long been apparent. In many instances, inventors have not the funds, the scientific knowledge or the mechanical skill to perfect their own inventions, hence aid in each of these directions is necessary in order that the country may reap the full benefit of the originality of its citizens.

Army Engineers Designated for Early Return

The War Department has announced that the following engineer units have been placed on the priority list for orders to return to this country:

Fortieth Engineers, placed on priority list Dec. 4, 33 officers and 623 men; 109th Engineers, Sappers, placed on priority Nov. 26; 311th Engineers and Engineer Train, Nov. 29, 57 officers, 1685 men; 312th Engineers, Nov. 26, headquarters, 24 officers and 29 men; headquarters company, two officers and 156 men; Co. A, three officers and 224 men; Co. B, five officers and 221 men; Co. C, five officers and 217 men; headquarters detachment, one officer and three men; Co. D, four officers and 245 men; Co. E, six officers and 237 men; Co. F, five officers and 241 men; 312th Engineers' Train, two officers and 74 men; 319th Engineers and Train, Dec. 4, four officers and 217 men; Co. E, four officers and 222 men; Engineer Casual Co. No. 1, Dec. 4, two officers and 223 men; Second Engineers, Dec. 6, Cos. F, I, K and Medical detachment, 20 officers and 760 men; Cos. D, E, G and H, 35 officers and 1000 men; 26th Engineers, Dec. 17; Co. A, eight officers and 253 men; Co. B, three officers and 181 men; 27th Engineers, Dec. 16, 46 officers and 1409 men; 29th Engineers, Dec. 12, headquarters detachment, two officers and eight men; Co. B, 14 officers and 238 men; Co. C, 11 officers and 185 men; Co. D, eight officers and 83 men; Co. E, 14 officers and 119 men; attached, three officers and 18 men; Co. F and detachment, 24 officers and 408 men; Engineer Casual Co. No. 1, Dec. 4, two officers and 223 men; 317th Engineers placed on priority Dec. 4, cancelled Dec. 16.

It was stated that the units generally arrive in this country from four to six weeks after being placed on the priority list.

New President for University of Wisconsin

Dr. Edward A. Birge was elected president of the University of Wisconsin Dec. 17 to succeed Dr. Charles R. Van Hise, who died on Nov. 19. Dr. Birge has been dean of the College of Letters and Science for the past 27 years, and a member of the faculty of the university for 43 years. He will assume the office of president at once, having been acting president since the death of Dr. Van Hise.

Notes From the Field

SOME OBSERVATIONS OF AN ITINERANT ENGINEER

In the issue of Dec. 5, *Engineering News-Record* told the story of the Spruce Production Division. The editorial tribute was well deserved, but I doubt whether the full spirit of that great job has been conveyed to the reader. I had the pleasure of seeing part of the railroad work on the Olympic Peninsula, one of the projects to which the article makes reference. I have never seen a job that for spirit and organization impressed me so favorably. One of the best railroad contractors said it could not be done in a year. It was completed in six months. Soldiers as well as civilians formed the working crews. Three shifts there were, and as one man laid down his pick, or quit his place, his successor took up the work—took it up immediately, with not ten minutes', not one minute's delay. Lunch was carried to the line to save time.

If the work was under high pressure, there was full compensation—good wages, model camps, excellent food. Throughout were enthusiasm and an unbeatable determination to put the job through.

Sometime all the men who were concerned with this great work will receive adequate credit. I wish I could name them, but I would have to start with the chief engineer, Mr. Kelliher, and the Siems-Carey Co., the general contractors, and continue down till I had named the last contractor's foreman.

And then, to be fair, I would have to go to each of the other Spruce Division's operations.

A great job, and I shall not soon lose its inspiration.

Linked with the memory of the job, too, are the hospitality of my hosts, Palmer, Pearson & Woods, one of the subcontractors, and the wonderful scenery of Lake Crescent, its waters rivaling those of Lake Tahoe and being reminiscent of the Italian lakes, its scenery recalling Champlain and George.

Last week I met two young engineers who have secured a return from a certain investment of time while in college that is well worth recording for the benefit of other engineers. They took courses in public speaking.

One of them, engaged in highway work, has made as rapid progress as any young engineer I have ever met, and he is pointed toward a great success. He recently played an important part in a bond-issue campaign, both through writing and speaking. To a large extent he attributed his rapid progress to the recognition that has come to him through his ability to speak in public.

The other young man, out of school only three and one half years, has built up a large acquaintance in his specialty — technical advertising — an acquaintance of direct and constant value to him in his work.

These men are at the entrance of their careers, but already they are beginning to reap returns from their ability as public speakers. As years go by and they talk from fuller experience, their speaking asset will develop in value in a rapidly increasing ratio.

Training and practice in public speaking are to the thinking man not merely exercises in overcoming bashfulness, though they are hardly more than that for the man who deals in platitudes and spread-eagleism. For the thinking man public speaking is a training in clear thinking and concise exposition. Success as a public speaker comes from having something worth while to say and saying it clearly and forcefully. The young engineers in question have not merely overcome stage fright. They have schooled themselves to analyze questions thoroughly so as to disclose the essentials, and have learned how to present these essentials effectively.

And the important things are yet to be said:

A little training in public speaking goes a long way;

It is never too late to learn.

Moral: *Go to the nearest Y. M. C. A. or similar institution and find out when the next course begins.*

E. J. M.

Aid for Highway Bridge Projects To Be Considered

Recent steps taken to organize a committee of bridge engineers as a Division of Bridges of the National Highways Association will be supplemented by a meeting of the committee Jan. 17 in New York City. A tentative outline of the program of work which this committee will undertake includes consideration of the subject of highway crossings over large rivers, advice and assistance in the broader preliminaries of highway bridge projects, and related matters in which special knowledge of bridge engineering may be made of service to highway development. The division will carry on its work on the principle of taking the initiative in any particular case only when called upon to do so. The functions of the committee are planned exclusively for service to the public good. Further development of the program of future work is expected to come about through the meeting on Jan. 17. G. Lindenthal is chairman of the division, and C. E. Fowler is secretary.

Promote Large Bond Issue for Missouri

A bond issue for $50,000,000 will be proposed for the building of public roads in Missouri, and will be urged upon the state legislature at the coming session by the Federation of Missouri Commercial Clubs. It is proposed to raise the funds for this construction, both principal and interest, from the motor-license tax.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS; 29 West 39th St., New York City; Jan. 15-16, New York.

AMERICAN WOOD PRESERVERS' ASSOCIATION; F. J. Angier, Mt. Royal Station, Baltimore, Md.; Jan. 28-29, St. Louis.

AMERICAN ROAD BUILDERS' ASSOCIATION; 150 Nassau St., New York City; Feb. 25-28, New York City.

NATIONAL RIVERS AND HARBORS CONGRESS; 824 Colorado Bldg., Washington, D. C.; Feb. 5-7, Washington, D. C.

The Engineers' Club of Philadelphia will hold a joint meeting with the Society of Automotive Engineers Jan. 21, at which G. Douglas Wardrop, editor of *Aërial Age Weekly*, will present a paper on "War Aviation in Retrospect; Commercial Aviation in Prospect," illustrated with motion pictures and lantern slides. Mr. Wardrop will speak on his experiences in the war zone, including his participation in bombing expeditions and observation of aërial battles. Dr. Grover G. Huebner, University of Pennsylvania, will speak on "The American Merchant Marine" at the weekly luncheon Jan. 7.

The County Surveyors' Association, the County Road Superintendents' Association and the State Highway Commission of Indiana will meet at the fifth annual road school of the School of Civil Engineering, Purdue University, Jan. 7 to 9, 1919. Important highway developments are under way and need the coöperation of all officials and others interested in road problems, it is announced. Prof. R. C. Yeoman, of Purdue University, Lafayette, Ind., may be addressed for programs and information.

The Nashville Engineering Association was addressed Jan. 21 by J. F. Walters, Nashville, Chattanooga & St. Louis Ry. on "Railroad Water Supply." Dr. C. R. Mann's recent report on engineering education was discussed by J. P. W. Brown. The annual meeting and dinner of the association will be held Jan. 6.

The New England Water-Works Association will hold its annual meeting in Boston Jan. 8. The meeting of the executive committee on the morning of Jan. 8 will be followed by a luncheon at the Hotel Brunswick, and reports of officers and committees will be received in the afternoon. Among the committee reports to be presented are the following: "Standard Specifications for Cast-Iron Pipe"; "Statistics of Water

Purification Plants"; "Proposed Standard Schedule for Grading Cities and Towns of United States with Reference to their Fire Defences and Physical Conditions," and "A National Water Law."

The Western Society of Engineers' nominees for office to be voted on before Jan. 17 are as follows: For president, D. S. Baldwin; vice-presidents, Kempster B. Miller, William M. Kinney and J. L. Hecht; treasurer, C. R. Dart; trustee for three years, E. T. Howson. Herbert C. Hoover has been named as recipient of the Washington Honor Award presented by the society for the first time. It was founded by John W. Alvord for meritorious public service. The presentation will be made at the society's Washington Birthday meeting. The annual meeting will be held Jan. 22 at the Sherman Hotel, Chicago.

The Engineers' Club of Trenton, N. J., was addressed Dec. 30 by W. W. Colpitts, who read a paper on "Some of the Questions Involved in Determining the Compensation Due the Railroads While Under Government Control."

PERSONAL NOTES

MAJ. EDWARD C. SCHMIDT, Ordnance Department, U. S. A., previously professor of railway engineering, University of Illinois, who was temporarily assigned to service with the United States Fuel Administration as assistant to the manager of the Fuel Conservation Section, has returned to service in the War Department.

WILLIAM B. LANDRETH has been named chief of the board of consulting engineers, New York State Canal System, succeeding Joseph Ripley, who has resigned to undertake irrigation and canal work in China. Mr. Landreth has been connected with the canal system of the state for many years and has served as deputy state engineer during the administrations of State Engineer Williams.

T. C. HUGHES, Tulsa, Okla., has been appointed consulting engineer to supervise the construction of hard-surfaced roads to be built by Tulsa County, under the $1,700,000 bond issue voted last year. He will coöperate with D. W. Patton, county engineer, who will be engineer of construction.

J. S. DODD, assistant road engineer of the Iowa Highway Commission, who has been taking the place of Maj. T. R. Agg as professor of highway engineering, Iowa State College, during the absence of the latter in the Army, has resigned and has returned to his duties with the commission. Major Agg has reassumed his teaching duties as professor of highway engineering.

H. T. SYMPSON, assistant division engineer, Eastern Division, Pennsylvania Lines West, with headquarters in Pittsburgh, has been appointed division engineer at Columbus, Ohio, succeeding G. R. Barry, promoted to division engineer, Chicago Terminal Division, as mentioned elsewhere.

GEORGE WESTON, assistant chief engineer, Board of Supervising Engineers, Chicago Traction, has resigned to become consulting engineer for the Philadelphia Rapid Transit Company.

W. J. ECK has been appointed signal engineer, Southern Ry. and associated lines, with headquarters in Washington, D. C.

V. I. SMART, formerly professor of railway engineering and transportation, McGill University, and J. A. Burnett, formerly electrical engineer, Grand Trunk Railway System, are now associated as consulting engineers, with offices at 821 New Birks Building, Montreal.

G. R. BARRY, division engineer, Pennsylvania Lines West, Columbus, Ohio, has been appointed division engineer, Chicago Terminal Division, Pennsylvania Lines, succeeding F. M. Graham, who was appointed supervising engineer, Southwest System of the Pennsylvania Lines, with offices in Columbus, as mentioned in *Engineering News-Record* of Dec. 12, p. 1102.

J. D. NEVILLE, county engineer of Lewis County, Washington, has been appointed division engineer of the southwest Washington counties for the Portland Cement Association.

HARLEY W. BRUNDIGE, Los Angeles, and Irving Martin, Stockton, Cal., have been appointed by Governor Stephens of the State Railroad Commission. Harry D. Loveland has been reappointed for another term.

MAJ. CLARK R. MANDIGO has returned to his duties as consulting engineer, Western Paving Brick Manufacturers' Association, with headquarters in Kansas City.

ROY J. FINCH, who for some years has been chief clerk of the New York State Engineer's office, has been appointed deputy state engineer to succeed William B. Landreth, who has been appointed chief of the board of consulting engineers, as mentioned elsewhere. Mr. Finch, a graduate of Rensselaer Polytechnic Institute, has been connected with the State Engineer's office since 1908, serving as supervising engineer and division engineer before taking the position of chief clerk.

ROSWELL M. ROPER, for the past year acting engineer for the water department, East Orange, N. J., has been appointed engineer of the department.

OBITUARY

CHARLES E. PHELPS, former chief engineer for the Public Service Commission of Maryland, whose death was noted in these columns last week, was born in 1871 and received his first technical training at Johns Hopkins University in 1891-1893. In 1902 he was retained by the City of Cleveland to report and estimate upon the cost of an electric street and commercial lighting project adopted by the city council. In 1903 he was retained by the cities of Johnstown, N. Y., and Rochester, N. Y., in litigation over the construction and operation of underground electric conduit systems, and by the city of Montreal to report and estimate upon an underground conduit system project. Two years later he was retained by the City of New York to assist in the investigation of charges for electric street lighting. Later he became chief engineer for the electric commission of the city of Baltimore, and was in charge of the construction of underground conduits. He also served as secretary of the Municipal Lighting Commission of Baltimore and as a member of the Sewerage Commission. In 1910 he became chief engineer for the Public Service Commission of Maryland, and five years later was appointed to the Maryland State Board of Health as engineering member.

GEORGE ALEXANDER JUST, president of the George A. Just Co., contracting engineers, Long Island City, N. Y., died Dec. 27 in New York City. He was born in 1850 and was a graduate of Rensselaer Polytechnic Institute. At one time he was associated with Cooper, Hewitt & Co. He had been in charge of the erection of many buildings in New York City.

DOUGLAS W. TAYLOR, formerly city engineer and superintendent of streets, Portland, Ore., died in that city Dec. 12, at the age of 68.

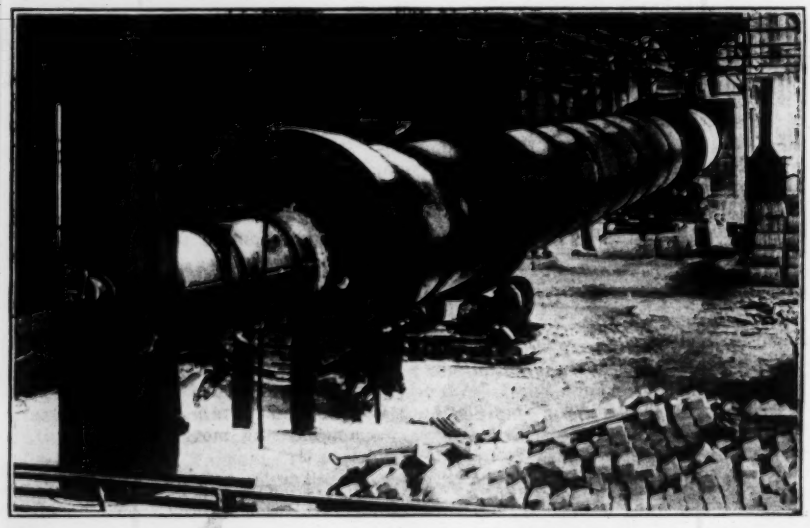
KARL A. FUNK, structural engineer, who for the past few months had been associated with the Deslauries Aircraft Corporation, Newark, N. J., died Dec. 11 in that city. He was graduated from the Massachusetts Institute of Technology in 1912 and had been in charge of the construction of several buildings in Boston.

Converts Waste Marble Into Valuable Byproduct

Vermont Company Now Produces Lime from Culls and Chips Formerly Discarded as Useless

During the past four years a large New England marble company has been experimenting with the stone usually wasted in its yards, with a view to converting it into a byproduct. Three years ago experiments were made on different grades of marble to determine the amount of lime obtainable by burning. The tests resulted in the company's building a modern well-equipped lime plant.

The raw material, as it comes to the plant, is in miscellaneous sizes. Blocks over 12 in. thick are conveyed in slings to a 60 x 48 jaw crusher, from which the material is conveyed by gravity through a gyratory crusher set to reduce all the material, including the sizes not sent through the jaw crusher, to 2 in. or less. The material is then elevated and screened, the screened product passing through a set of 36 x 16-in. rolls to reduce it to ¼ in. or less. All of the material is then elevated and conveyed into storage or kiln bins, from which it can be drawn at any desired time.



ELECTRICALLY DRIVEN LIMEKILN

The material from the kiln bin is sent into the kiln by a feeder. The kiln is patented after the familiar cement design, 8 ft. in diameter, 20 ft. long, installed with a 4% pitch. It is belt driven from a 30-hp. variable-speed motor, geared to give 10 ft. from 0.5 to 1.5 revolutions per minute, as desired.

The producer gas is introduced through a flue into the lower end of the kiln, and in burning furnishes the heat for calcining the stone as it gradually rolls through the revolving cylinder. A temperature of 2200 deg. F. is maintained, which drives off the CO from the stone, leaving the quicklime. The hot lime drops from the lower end of the kiln into a revolving cylinder, where it is cooled by the draft of air on its way into the kiln to support combustion. The cooled lime is elevated from the discharge of the cooler and is then deposited in lime-storage bins.

Reduction of Labor Shortage Reported by Department

That the supply of labor is rapidly meeting the demand is indicated in a report received from the Department of Labor. The information in the bulletin, the department says, is received by telegraph from local representatives of the Federal Employment Service, and is used in making replacements, in allocating labor, in the curtailment and cancellation of war contracts, and in the demobilization of the Army. The bulletin shows that there is a surplus already in the Middle West, West and Far West, mostly in the cities, and some slight surplus in certain lines is reported from Boston, Buffalo and Rochester, as well as from Nashville, Tenn., and cities farther south. The greatest surplus reported, in Dayton, Ohio, amounts to 5000. The New England States generally report the supply and demand about equal, as do some of the Middle Western States and the South generally. Los Angeles, Cal., also reports the demand about equal to the supply.

Most of the shortage appears to be in the Atlantic States, from Connecticut to Florida. The greatest, amounting to 15,000, occurs in Philadelphia, but is 10,000 less than is shown in the preceding report. Although there are shortages in the manufacturing cities of eastern Ohio, the report states that they are reducing rapidly. Pittsburgh, Harrisburg, Scranton, Allentown and South Bethlehem, in Pennsylvania, all report shortages, more or less in amount, as well as the southern cities of Atlanta, Louisville, Baltimore, Lynchburg, Norfolk and Chattanooga.

Record Non-Stop Tractor Run

A run of 480 miles from Peoria, Ill., to Detroit, Mich., in six days, was recently made by a caterpillar tractor. This is said to be a record for tractors, and to mark a new milestone in tractor progress.

The tractor, which was of the 85 hp. Holt type, was delivered to representatives of the United States Government, and the run was made in the nature of a test of the machine. It followed highways of all kinds, many in very bad condition, and although the speed on road is rated at three miles an hour, it did a little better, covering the distance in 151 hours. Despite the bad roads, however, the tractor was in such good condition at the end of the run that it was immediately ordered overland to the Army Proving Grounds at Aberdeen, Md. There were no mechanical breakdowns, and inspection showed the machine to be in excellent condition.

BUSINESS NOTES

The Maxwell Engineering Co., formerly at 156 Twenty-fourth St., Brooklyn, N. Y., is now completing its new yard, plant, and office building at 103 Thirteenth St., Brooklyn.

The Carbo Steel Post Co., formerly of Chicago Heights, Ill., has changed its address to 2600 West 111th St., Chicago, Ill.

The Chicago office of the Electro-Bleaching Gas Co., 11 La Salle St., which was temporarily closed on account of the war, is to reopen, and will be in charge of G. R. Ellis, as formerly.

TRADE PUBLICATIONS

The Raymond Impact Pulverizer Co., Chicago, Ill., has issued catalogue No. 13, covering its equipment of roller mills and pulverizers equipped with air separation for grinding all kinds of materials to powdered form.

"Steel Pile Forms" is the title of bulletin No. 12-A issued by the Northwestern Steel & Iron Works of Eau Claire, Wis., builders of engines, concrete mixers and steel forms. It is an 8 x 10 twenty-page pamphlet illustrating and describing the product of the works.

The Milliken Brothers Mfg. Co., New York City, has issued a 23-p. 6 x 9 ½-in. booklet entitled "Space and Speed in Steel Buildings," describing the standardized truss unit system of building construction designed and manufactured by the company.